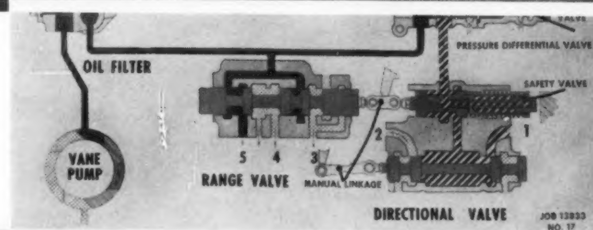
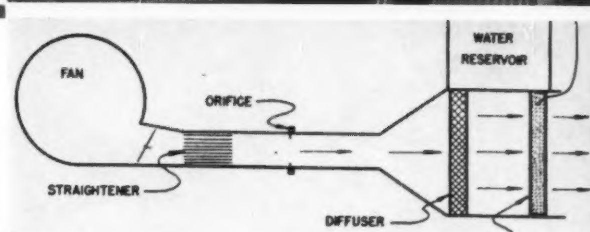
DECEMBER 1960

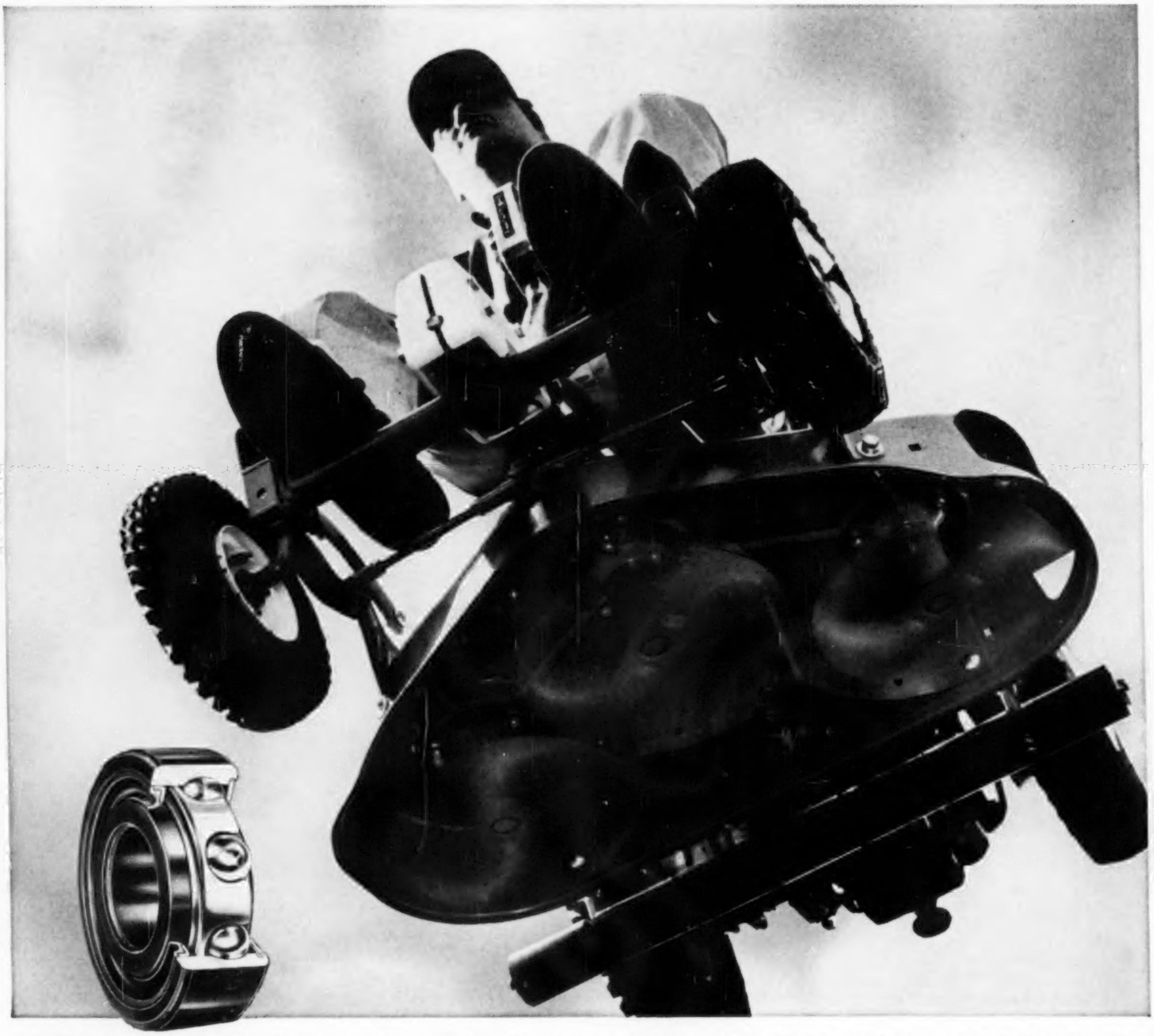
Agricultural Engineering

The Journal of the American Society of Agricultural Engineers





NEW DEPARTURE CASE HISTORY

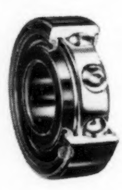


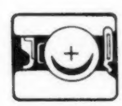
HOW N/D BALL BEARINGS REDUCE MOWER MAINTENANCE AND PRODUCTION COSTS!

PROBLEM: Manufacturer of well-known power lawn mower wanted to make unit more maintenance-free.

SOLUTION: Complete re-evaluation of all rotating parts including a study of rotary blade bearings by N/D Sales Engineer. His recommendation: Replace six existing non-integrally sealed bearings with lubricated-for-life New Departure ball bearings. These factory greased bearings are equipped with integral Sentri-Seals* and Land-Riding Seals. Results: Greater consumer sales appeal by doing away with the need for relubrication maintenance. In addition, N/D's compact ball bearings reduce production cost by eliminating separate bearing seals and six unnecessary grease fittings.

If you're designing new products involving bearings, invite a N/D Sales Engineer to your next design discussion. His knowledge of bearing engineering may result in a savings and valuable new product sales features. Contact him at your local N/D Sales Engineering Office, or call or write New Departure, Division of General Motors Corporation, Bristol, Connecticut. *New Departure Registered Trade Name.





Integrally sealed N/D ball bearings eliminate need for relubrication, grease fittings and separate seals. These heavy-duty N/D bearings with Sentri-Seals* and Land-Riding Seals, shut out moist or dry contaminants.

NEW DEPARTURE

BALL BEARINGS · PROVED RELIABILITY YOU CAN BUILD AROUND

Agricultural Engineering

Established 1920

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JAMES BASSELMAN, *Editor and Publisher*

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Wallace Ashby Elected Honorary Member

IN recognition of his 44 years of distinguished service to the agricultural engineering profession, the Council of ASAE has recently elected Wallace Ashby to the grade of Honorary Member in the Society.

Mr. Ashby, who has been a member of ASAE since 1916, was born on August 23, 1890, in Des Moines, Iowa. He received a B.S. degree in agricultural engineering from Iowa State University in 1913. After one year of teaching in the agricultural engineering department at ISU, he was with the USDA as a "barn architect," in what later became known as the Cooperative Farm Buildings Plan Exchange. With the exception of two years army service during World War I, he remained here until 1920.

Wallace Ashby

The next eight years were spent as an agricultural engineer in reclaiming cut-over, burned-over, swamp lands in Northern Minnesota. His outstanding record in this assignment was duly recognized by Iowa State University in awarding him the professional degree of agricultural engineer in 1924.

In 1928 he rejoined the USDA as an agricultural engineer where he was engaged in studying and evaluating plows and other tillage equipment from a standpoint of controlling corn borers. His outstanding efforts in this project were rewarded in 1931 when he was elevated to head the enlarged program of farm buildings research in the then newly-organized Bureau of Agricultural Engineering—now known as Livestock Engineering and Farm Structures Research Branch of the Agricultural Engineering Research Division. He held this position until his retirement in August of this year.

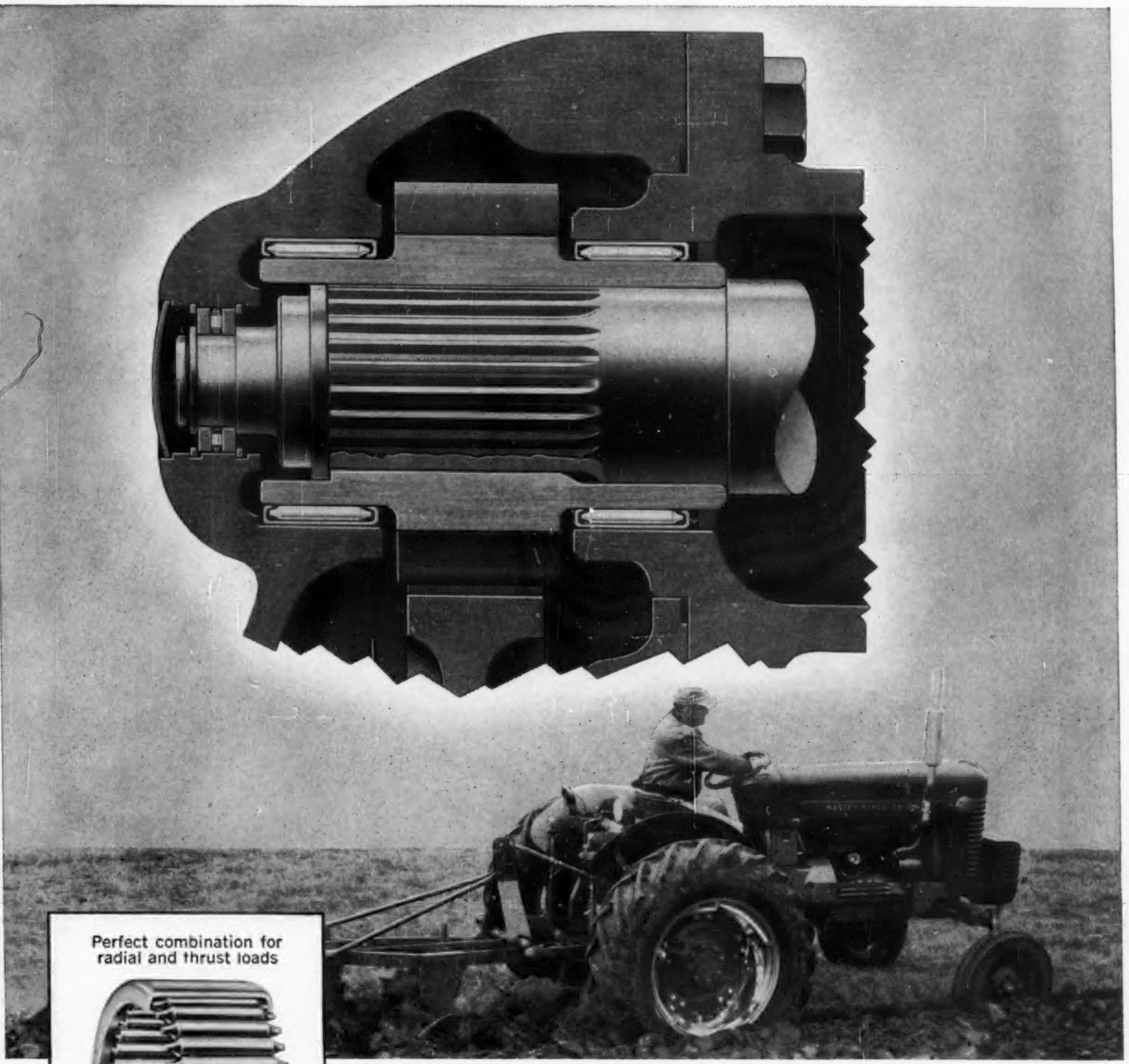
Among Mr. Ashby's accomplishments are the 1931 preparation of reports for President Hoover's Conference on Home Building and Home Ownership; directing and analyzing the engineering phases of a survey of housing needs in 600,000 U.S. farm homes in 1934, the resulting plans for which appear even today in popular magazines; pioneering work in establishing a long series of studies on structures, equipment and methods for conditioning and storing corn and seeds; and serving during World War II in an agricultural engineering capacity and as a metals consultant in the Office of Agricultural Defense Relations and later as assistant director of the Hemp Division, Commodity Credit Corp. In this capacity he was instrumental in developing domestic sources of hemp to replace supplies which had been lost with the Philippines.

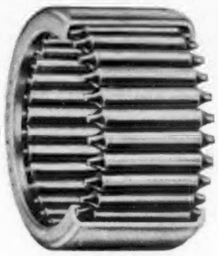
A prolific writer, he has authored and co-authored numerous articles and technical papers in addition to his duties of supervising preparation of USDA publications and other miscellaneous writing by members of his staff.

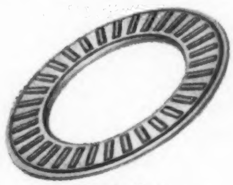
In 1956 he was selected to represent the USDA at the First International Congress on Farm Buildings Research at Lund, Sweden. At the same time he also visited seven European countries to study their research and development work on farm buildings.

An active member of the Society since he joined, he was advanced to the status of Life Fellow in 1952. In 1958 he received the John Deere Gold Medal for "distinguished achievement in the application of science and art to the soil." He has also been chairman of Farm Structures Division, Washington, D. C. Section, and Committee on Farm Buildings Research Needs and Statistics; and a member of the Committee on Ventilation of Farm Buildings, Land Development Committee, and Committee on Farm Structures Research.

He has also taken an active part in the National Fire Protection Association and is a member of the American Society for Testing Materials.







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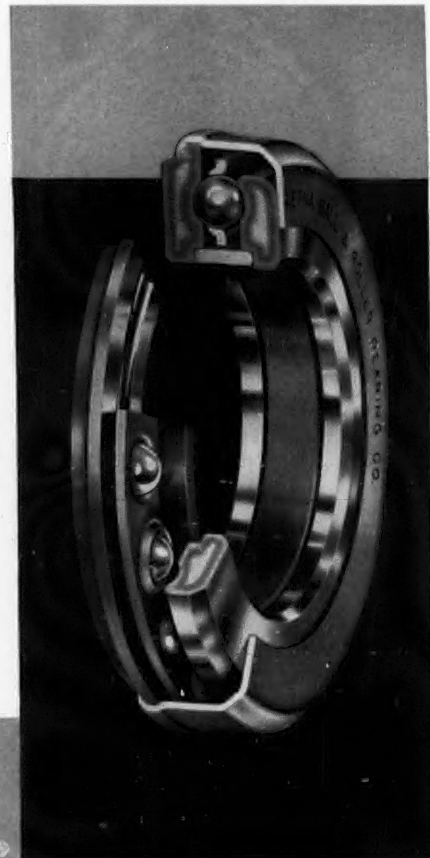

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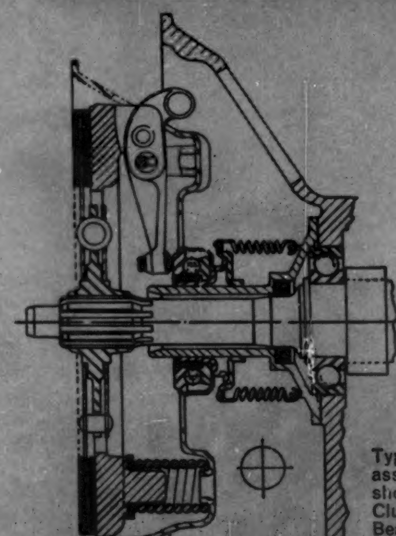
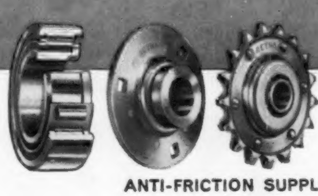


Typical clutch assembly showing Aetna Clutch Release Bearing in released position.



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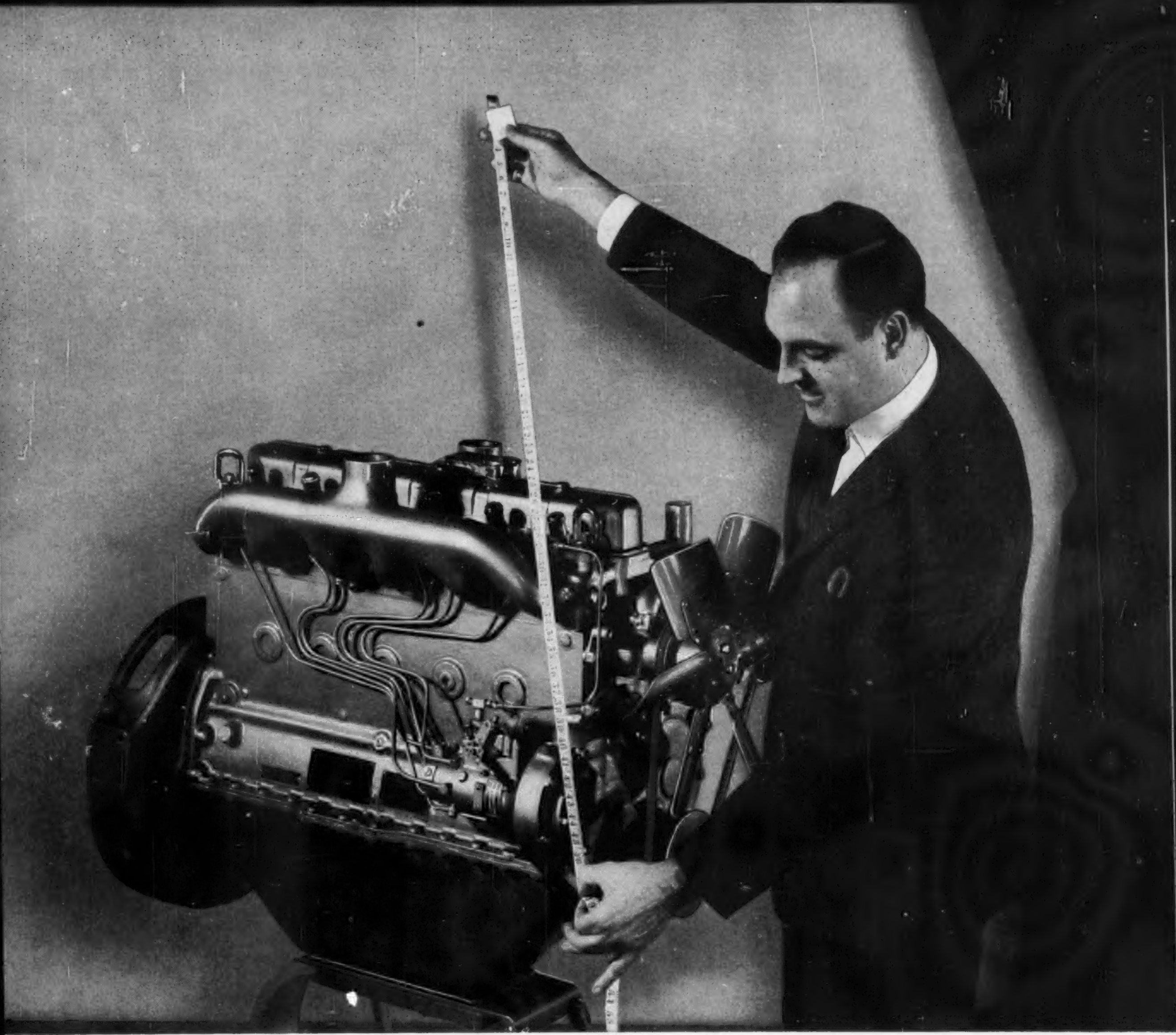

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Report to Readers . . .

OPERATOR REACTION IS ACID TEST OF AUTOMATIC TRACTOR STEERING

It was reported to an ASAE meeting this month that operator reaction to automatic tractor steering may be influenced more by an operator's personal opinion of the steering device itself than by his actual use of it. This was the conclusion reached in a study made by a USDA-Iowa SU agricultural-engineering research team, in cooperation with the psychology department of the university. . . . . The operator with the favorable opinion of automatic steering showed less fatigue at the end of the day, while the operator who did not like or trust the automatic system was more fatigued after a day's use of it. . . . . A study was also made, as part of this experiment, to determine what improvements in the quality of the corn cultivating operation might be expected to accrue from automatic steering. The engineers report that, while they found power steering resulted in greater stand reduction, lower yields, and poorer weed control than did manual steering, they were optimistic that new, improved automatic-guidance systems can improve this picture.

PLANTING SEED IN FIRMED SOIL IMPROVES SEEDLING EMERGENCE

Of particular significance to designers and builders of planters – corn, bean, sugarbeet, etc. – are the findings reported by a research team comprising a USDA plant pathologist and two Michigan AES agricultural engineers. Their experiments thus far indicate that seedlings may emerge better if planters are designed to press the seeds into firmed soil and then cover them with loose earth. Firming the soil at seed level appears to promote maximum seedling emergence by ensuring moisture transfer by capillary action from below. A loose soil covering was found to minimize crusting of the surface and to permit oxygen to circulate freely. These studies also indicate that such firming of the soil is of no benefit if adequate moisture is not available below the seed.

ENGINEERS CUT COSTS IN APPLYING AMMONIA

Based on results of a two-year field study, an Illinois AES agricultural engineer reports that crop production costs can be cut by combining the application of anhydrous ammonia and soil tillage in one operation. He found that separate application of the ammonia cost $2 or more an acre; also, the extra travel over the field increased soil compaction. . . . . In these tests the ammonia was applied under the furrow slice of a moldboard plow or behind the rear gangs of wheel-mounted disk harrows. The tests thus far have shown that ammonia can be applied during tillage with very low losses. A good job of tillage is essential, however, and the ammonia needs to be released under a fairly loose soil. . . . . Any tillage tool can be used to apply the anhydrous ammonia if it permits its release at depths of more than 4 inches with loose soil above. This would include moldboard and disk plows, disk harrows of several types, spring-tooth harrows, field cultivators, and subsoilers.

REDUCED TRAVEL SPEED INCREASES EFFICIENCY OF COTTON PICKERS

Field tests conducted by a team of USDA-California AES agricultural engineers showed that the picking efficiency of barbed-spindle cotton pickers could be increased an average of 2.5 percent. This was done by reducing travel speed of the pickers from 2.1 to 1.5 mph by changing the low-gear ratios in the picker tractor. Since the speed of the spindle-drum drive was not affected by the change, the drum ran faster than when normally synchronized with the forward speed of the tractor. . . . . Four combinations of tractor and spindle-drum speeds – two synchronized and two unsynchronized – were tested. The picking efficiencies of the two unsynchronized speed combinations were from 1 to 3 percent greater than either of the synchronized speeds in all tests. The highest efficiency was obtained with the unsynchronized speeds of 1.5 mph for the tractor and 80 rpm for the spindle drum.

(Continued on page 790)

. . . Report to Readers (Continued from page 788)

ENGINEERS PROPOSE UNIFORM FARM-BUILDING CONSTRUCTION STANDARDS

Two Iowa agricultural engineers reported progress to an ASAE meeting this month in developing proposed ASAE standards for farm buildings and building materials. They include two sets of recommendations: one dealing with wind, snow and other loads on structures, and the other covering properties of materials. . . . . Already, it appears, there is general agreement among those working in this field on magnitudes and distribution of wind loads, and what is believed will prove an acceptable recommendation is expected to be released soon. . . . . But there is wide divergence of opinion on the matter of snow loads applicable to farm buildings, and because of this it is not likely that an acceptable recommendation can be offered until there is more of a meeting of minds. . . . . The Iowa engineers recommend that, until uniform structural standards are available, designers and builders of farm structures make use of such standards as have been developed by technical groups.

ENGINEERS DETERMINE SHADE AREA REQUIREMENTS OF BEEF FEEDLOTS

In spite of the high daily summer temperatures in California Imperial Valley, it is estimated that one-fourth of the state's feedlot cattle are in this area, in which summer daily temperatures average about 90 F. By the use of shades California AES agricultural engineers and other researchers have demonstrated that the spherical radiant heat load on cattle can be reduced as much as 50 percent, though the shades do not appreciably lower the air temperature. While commercial feedlot operators allow between 16 and 25 sq. ft. of shade per animal, the general opinion is that this is not enough. Results of an 84-day trial conducted by the researchers indicated that steers having access to an area supplying 48 sq. ft. of shade per animal gained 2.25 lb. per day, while the gain in the case of steers having 27 sq. ft. of shade was 2.06 lb. per day. This experiment also included trials with both high-energy and low-energy rations for each lot of steers, in which those fed the former gained significantly faster than those fed the latter. . . . . The shade material used in this trial was galvanized steel painted white on top.

MECHANICAL HARVESTING OF CUCUMBERS UNDER STUDY

Michigan SU agricultural engineering and horticultural researchers have been studying the underlying principles of harvesting cucumbers, on which the development of a mechanical harvester might be based. An experimental harvester developed by the engineers provided the means for obtaining data on machine efficiency, design parameters, and reduction in yield and return. The capacity of the harvester varied from 0.8 to 1.2 acres per hour; its over-all efficiency was rated at about 25 percent based on nine harvests. . . . . A pneumatic vine trainer proved more than 75 percent effective in positioning vines in the proper direction for harvesting, but the per acre return was reduced by 10 percent by the training operation.

ENGINEERS STUDY HARVESTING OF DRY BEANS BY DIRECT COMBINING

Direct field harvesting of dry beans with a combine is considered possible as the result of tests conducted during two seasons by Cornell agricultural engineers. Commercial feasibility of the practice is based on losses of not to exceed 1½ bushels per acre. Several different harvester components were field-tested in the course of this study, but best results were obtained with a self-propelled, direct bean combine. The regular pickup and elevating attachment was removed and replaced with a special elevator, cutting mechanism and bean-lifting head. . . . . One season's results from the use of this machine for the direct combining of red kidney beans were satisfactory. In one field, the total losses from its use were 1.57 bushels per acre. With the conventional method of pulling, raking and pickup combining, the losses on the same field were 2.04 bushels per acre. Other tests resulted in somewhat higher losses, but in no instance did the losses from direct combining exceed those resulting from the conventional method. . . . . The Cornell engineers are directing further effort to developing additional equipment for direct combining of beans.

TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

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BEARING BRIEFINGS

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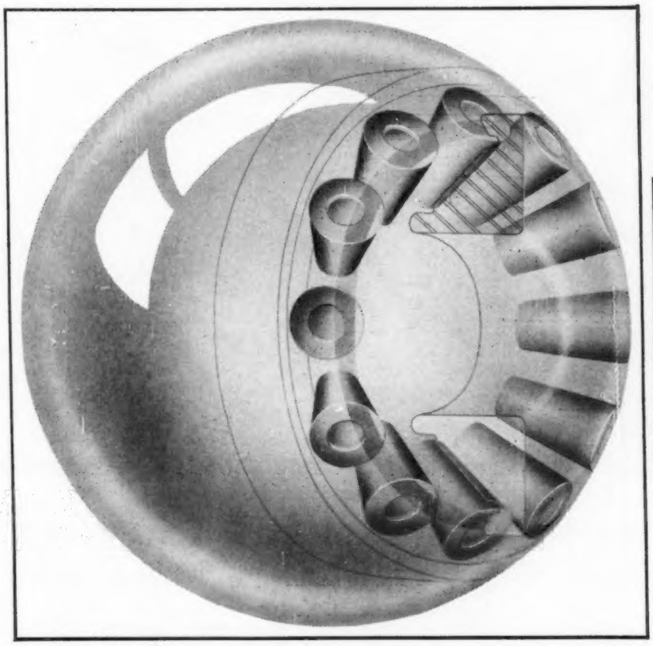

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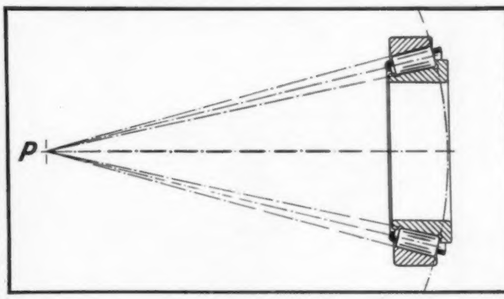

True rolling of tapered bearing elements depends upon maintaining a true spherical radius during manufacture.

For a tapered roller bearing to achieve maximum performance, i.e., maximum life and capacity under load, it must have true sphericity — a condition of bearing geometry which permits true rolling of the tapered rollers in the raceway.

True rolling in tapered bearing elements is the result of maintaining a critical geometric relationship between the raceways and the contact surfaces of each roller. True rolling is essential to maximum performance. Without it, premature bearing failure is certain.

As engineers know, a tapered roller will describe a true circle when rolled on a plane surface. *It will always roll in this one path precisely, without sliding or skewing.* But to put true rolling to work in a bearing which can carry both heavy thrust and radial loads, it is essential that the rollers *and* the raceway have a true spherical radius, or sphericity. The drawing illustrates this condition.

If each roller in the bearing were to be extended in length, while retaining its taper, it would form a cone, terminating at point "P". All cones generated from all rollers would meet at point "P", which is also the center of the hypothetical sphere shown. The surface of the sphere would *touch all points on each roller's head!*

In effect, then, each roller's taper determines the radius of a hypothetical sphere whose surface, in turn, determines the correct contour for each roller head. Only when these conditions are satisfied in design, and when they are rigidly held during manufacture, will true rolling take place. In the manufacture of each Bower tapered roller bearing, sphericity is held within extremely narrow limits by means of special Bower-designed precision grinders. The consistent accuracy possible with these machines is one major reason why Bower roller bearings provide maximum performance under all speeds and loads up to the bearing's maximum rating.

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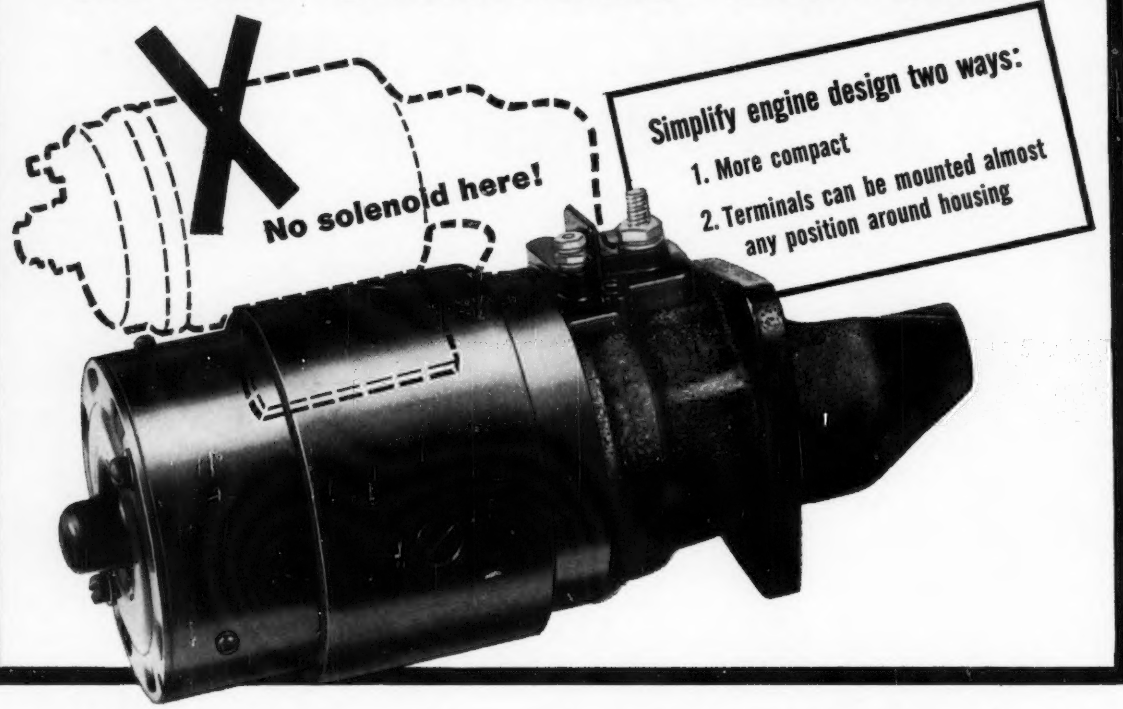

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Link-Belt offers augers in a full range of diameters, gauges and pitches . . . with helicoid, sectional and many other types of flighting. For further details plus any engineering counsel you may need, contact your nearest Link-Belt office. Remember to ask for Book 2989.

JOHN DEERE 4-ROW CORN HEAD relies on 8 Link-Belt augers for positive feeding, conveying and discharging of corn.

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As demonstrated on this corn planter, servicing 320 acres, the positive compacting action of semi-pneumatic, ORCO "SOIL KING" press wheel tires assured faster germination, improved stand, and boosted crop yield by 10%. **Note absence of dirt and litter on press tires.**

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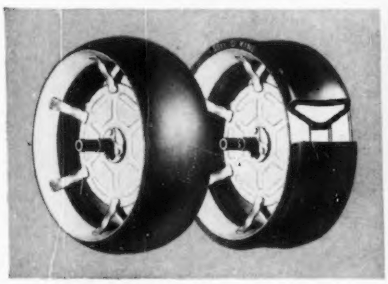
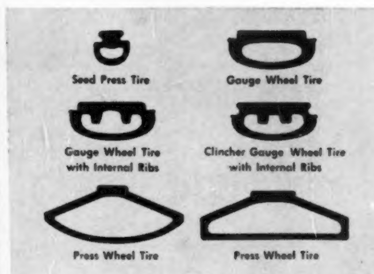
meet planting schedules—improve crop yield





DESIGNED TO THE JOB, ORCO "SOIL KING" tires are made of a special rubber compound which fully utilizes the advantages of high wear resistance, long flex life, low compression set, high tensile strength, and resistance to sun, weather, and aging. "SOIL KING" tires flex clean, roll easily, and assure better flotation in loose soil—better penetration in hard soil.

COMPACTION EFFECT of ORCO "SOIL KING" semi-pneumatic rubber press tires conserves moisture and assures the most favorable planting conditions in all soil types and conditions. Farmers report that, in dry soils, compaction minimizes air pockets and, by improving capillary action of moisture in the soil, speeds germination. Note clean crown contour and sharp edges of compacted seed rows above.

CROSS-SECTIONS SHOW WHY the air space in "SOIL KING" semi-pneumatic tires permits the full use of the natural flexing action of rubber. Tires are immune to puncture or blow-out since no compressed air or inner tubes are used. Each type of "SOIL KING" tire is designed and constructed for best service in its field. For full information, write today to The Ohio Rubber Company for free, 16-page Bulletin No. 429.

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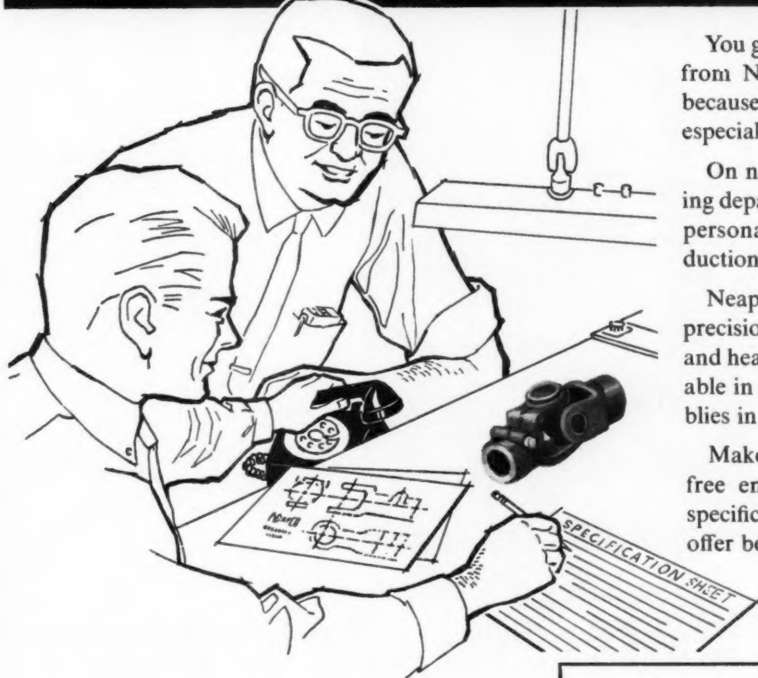

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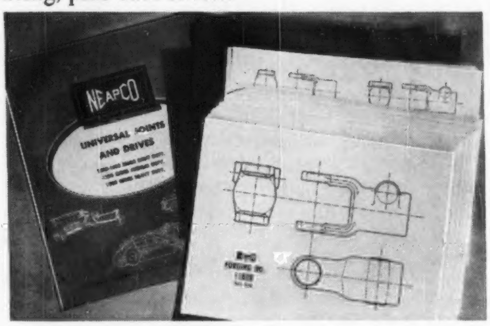

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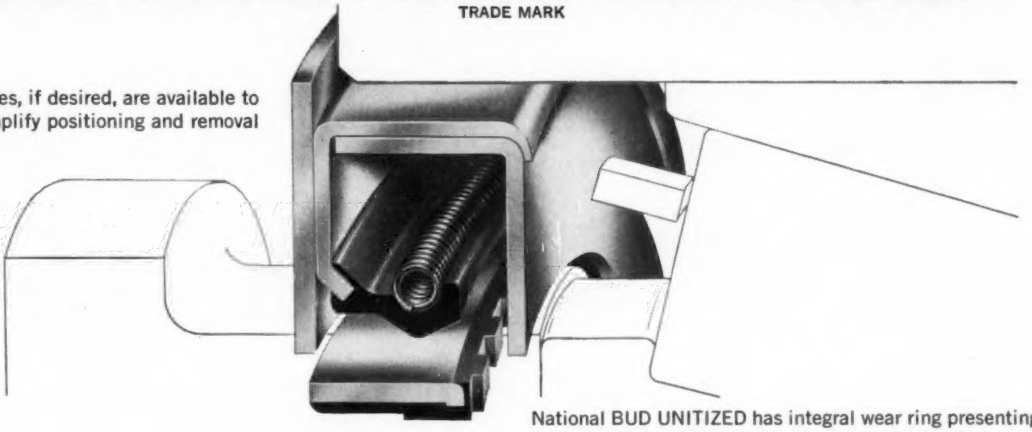

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Millions of hours of field work have proved that *exclusive* IH Multi-Range power really saves money. Additional millions of work hours have further proved that "farm-easy" features like Torque Amplifier, Hydra-Touch hydraulic control . . . Fast-Hitch and many others are sensible savers of time and labor—not untried ideas.

Compare a Farmall or International with any other "new" tractor. The more you compare, the more reasons you'll find to go IH with power that's years ahead and proved by 40 million hours' experience.

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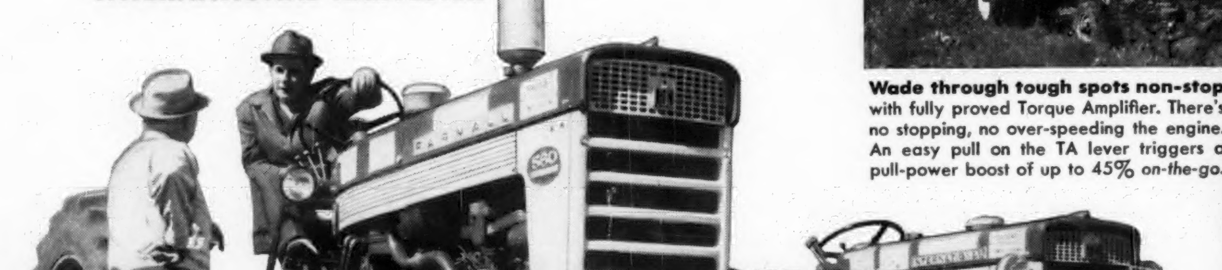
Save on the IH Early Trader's Bonus Plan. Get cash for dealing now on a proved Farmall or International tractor. IH pays interest at the rate of 6% on your trade-in and/or down payment from the time the deal is closed. See your International Harvester dealer, now!



Exclusive Multi-Range Engines deliver the big power you need to master tough jobs with new ease and economy. Only IH Multi-Range tractors give both top big power and small tractor economy on light loads.

"Loaf" on Light Jobs. With Multi-Range power, shift up to a high gear, reduce engine speed for the right pace to match the job. Big-power engines "loaf" along, give you small tractor economy.

Wade through tough spots non-stop with fully proved Torque Amplifier. There's no stopping, no over-speeding the engine. An easy pull on the TA lever triggers a pull-power boost of up to 45% *on-the-go.*

Agricultural Engineering

December 1960
Number 12
Volume 41

James Basselman, *Editor*

Constitutional Changes

SEVERAL ASAE members, and especially non-members of ASAE or those unfamiliar with the activities of the ASAE Council, have felt that some confusion exists in regard to the governing body of the Society. Some have had the impression that the Council is something other than the board of directors, and are uncertain as to its function.

To correct this situation, a properly-signed petition to modify the ASAE Constitution so that the Society's governing body might be referred to as "Board of Directors" rather than "Council" was read before the business meeting of ASAE during its 53rd Annual Meeting at Ohio State University in June 1960. The new proposal also specifies that the members of that body, particularly the councilors, be designated as "Directors."

Once a petition of this type has been presented at a business meeting of the Society and the members present at the meeting (not less than fifty voting in favor thereof) have supported its proposed action, the executive secretary of ASAE shall mail to each person entitled to vote a copy of the proposed amendment, at least sixty days previous to the next business meeting of the Society. A ballot shall accompany the proposed amendment and voting shall be by sealed letter ballot, closing at noon of the twentieth day preceding the business meeting of the Society following the mailing. Mailing of the ballot will be done in February at the same time ballots are mailed for electing new officers. Adoption of the amendment shall require a vote in its favor of two-thirds of the votes cast. Results of voting will be announced at the 54th Annual Meeting of the Society, June 1961, the first meeting following the close of the ballot, and, if adopted, it shall thereupon take effect.

The following sections of the Constitution will be affected by the proposed amendment:

Article C 4, Section 6; Article C 5, Sections 1, 2, 3, and 4; Article C 6, Sections 1, 2, 3, 4, and 5; Article C 7, Section 4; Article C 8, Sections 2, 3, 4, and 5; Article C 9, Sections 1, 3, 4, and 5; Article C 10, Section 1; Article C 11, Section 1; Article C 12, Section 1; Article C 13, Section 1; Article C 14, Section 1; Article C 15, Section 2; Article C 16, Sections 1 and 2, and any other places in the Constitution in which the governing body may be named.

1958 Constitutional Change

A study of the procedure involved in amending the ASAE Constitution uncovered reference to the latest such change that took place in 1958. The amendment at that time provided for an increase from nine to eleven in the number of members serving on the Council. Reference is made to the previous action at this time because, unlike the present proposal, the 1958 amendment required a reasonable period of time to bring about a transition from the old system to the new. Strangely enough, provision for the previous amendment to become fully effective will be included in the same mailing as the present proprosal.

The 1958 amendment provided for the election of a president-elect to serve one year on the Council before and after his term as president. It also provided for the election of one councilor to represent each ASAE division – their terms to be for two years each. The transition began in 1959 with the election of a president and president-elect. One councilor was also elected to represent the Power and Machinery Division for a two-year term. In 1960 only the president-elect (three-year term) and two councilors (representing the Soil and Water and Electric Power and Processing Divisions for two-year terms each) were elected. The procedure for electing vice-presidents did not change. On the 1961 ballot three councilors will be elected to represent the Farm Structures and Education and Research Division and one to replace the first councilor serving as a representative for the Power and Machinery Division for two years, whose term expires.

Following the installation of officers at the 54th Annual Meeting in June the transition will be completed and the governing body, whether it be called "Council" or "Board of Directors," will consist of one president; one president-elect; one past-president, three vice-presidents; and one councilor or director for each ASAE division.

Consulting Agricultural Engineers

MEMBERS of ASAE who are employed as consulting agricultural engineers or wish to be listed as such in the "Consulting Agricultural Engineers" section of the 1961 AGRICULTURAL ENGINEERS YEARBOOK (See pages 393 to 395, 1960 edition) are urged to supply the necessary information by February 1, 1961.

All that is required to be listed is to furnish: complete name and address, a brief description of consulting services (not to exceed 50 words), specify whether registered professional engineer, and list specialty by division interest; such as, Power and Machinery, Farm Structures, Electric Power and Processing, and Soil and Water. Those whose services extend beyond one division may be listed accordingly. Send the above information to the attention of J. Basselman, Editor, AGRICULTURAL ENGINEERS YEARBOOK, 420 Main St., St. Joseph, Mich.

Applications of Fluorocarbon Resins in Farm Equipment

R. D. Pillsbury, Jr.

Improved equipment efficiency and cost savings offered by new family of plastics

USE of fluorocarbon resins can assist the agricultural equipment manufacturer in producing better equipment, often at reduced production costs. At the same time, the equipment can claim the added sales appeal of lower maintenance and upkeep.

In many cases, equipment costs can be reduced by taking advantage of the self-lubricating properties of Teflon* resins, both to simplify design and to eliminate oil or grease fittings now required for lubrication of bearings, bushings and seals. Often bearings and seals of these resins are easier to install, require less critical tolerances and are compatible with less-expensive materials. Also, their slippery surface, to which almost nothing sticks, can make possible new and simpler equipment, or make the present equipment more satisfactory than has heretofore been possible.

While price is a major consideration in any competitive industry, the sales appeal of an improved product cannot be ignored. The unique combination of mechanical and chemical properties that are inherent in fluorocarbons can provide the lower maintenance requirements, increased work load, and longer life expectancy desired by the user.

Desirable Properties

Almost all plastics have low friction, resistance to sticking, and good chemical resistance, but the fluorocarbon resins possess these properties to the highest degree of any plastic material of construction. Coupled with these are complete resistance to weather and retention of useful mechanical properties over a 900 F range of temperatures.

These properties are available in the older, more-familiar Teflon TFE (polytetrafluoroethylene) resins and the new Teflon 100 FEP (fluorinated ethylene propylene) resin, which became available in commercial quantities in February, 1960.

The latter (FEP) resin can be molded and extruded in much the same manner as other thermoplastics, whereas the TFE resins are molded by powder metallurgy methods. FEP resin is recommended for continuous service up to 400 F, while TFE resins are recommended for continuous service up to 500 F. Both are readily machinable.

It should be noted that many skilled fabricators are in business to handle any of these resins. Since a fabricator has a range of control over design properties such as tensile strength, flexural modulus and deformation under load (1)†, it is beneficial to rely on his knowledge and assistance to obtain the best characteristics at the most reasonable cost.

Filled Compositions

For many mechanical applications, the performance of Teflon resins can be modified by the addition of fillers during fabrication. Graphite, copper, bronze, ceramics, etc., and inorganic fibers such as glass and asbestos are used as filler materials. The effect of a filler on the mechanical properties of these resins is to increase

- Resistance to initial deformation under load by approximately 25 percent
- Resistance to rotating-shaft wear by as much as 500 times
- Stiffness by a factor of 2 to 3
- Thermal conductivity by a factor of 5
- Resistance to creep approximately twofold
- Thermal dimensional stability by a factor of 2
- Hardness by approximately 10 percent.

Expanded metal can be encapsulated in the resin, or it may be bonded to a metal or wire backing to further control thermal expansion, to permit easier attachment and to help dissipate frictional heat.

Bearings, piston rings, bushings and many seals, which operate on a repeating surface, are normally made of filled compositions. In cases where a non-repeating wear surface is involved, like a fertilizer chute or plow face, unfilled resins may perform better than a filled composition.

Frictional Properties

From the beginning, the smooth surface and slippery "feel" of parts made with fluorocarbon resins aroused the keen interest of engineers, designers, and scientific investigators. Their work paved the way to the use of these resins in non-lubricated mechanisms and machines. The low-friction, antistick properties of these resins probably offer more potential for agricultural applications than any other single property.

Early investigators reported very low coefficients of friction for these resins, sometimes as low as 0.02. However, conflicting results indicated that this low coefficient of friction was not maintained under all conditions. As the mechanism of friction for materials that deform plastically as well as elastically at relatively low loads became better understood, these apparent contradictions were explained. Friction theory now holds that the coefficient of friction depends not only on the bulk mechanical properties of the material, but also on surface geometry, on load and on other sliding conditions (2).

Paper presented at a meeting of the Pennsylvania Section of the American Society of Agricultural Engineers at University Park, Pa., April 1960.

The author — R. D. PILLSBURY, JR. — is applications engineer, polychemicals department, E. I. du Pont de Nemours & Co., Wilmington, Del.

*The name "Teflon," as used in this paper, is a registered trademark of E. I. du Pont de Nemours & Co.

†Numbers in parentheses refer to the appended references.

When data from the many friction studies are combined, as in Fig. 1, the conflicts become resolved. As the load on unreinforced Teflon resins is increased up to about 50 lb, the static coefficient of friction decreases significantly. As the load is further increased, the decrease in coefficient is very slow. It is in this high-load range that fluorocarbons have an exceptionally low coefficient of friction. The continual drop in coefficient with load increase indicates that a bearing surface of these resins will not seize, even under extremely high loads.

It should be noted that although the static coefficient of friction of the FEP resin is slightly higher than that of the TFE resins, it is still comparable to, or better than, the coefficients reported for many other common dry-bearing materials.

Effect of speed on the coefficient of friction at different loads is shown in Fig. 2. As the sliding speed rises to about 150 fpm, the coefficient of friction for unfilled Teflon increases rapidly. This pattern of change in coefficient eliminates "stick-slip" vibrations and noise.

Above about 150 fpm, sliding speed has relatively little effect until the surface temperature exceeds the 620 F crystalline gel point of TFE resins or the 550 F melting point of the FEP resin. When this occurs, the coefficient of friction increased rapidly. The lower coefficient of friction for the filled composition at higher speeds is particularly interesting, and is believed to result from the increased hardness of the material. Similar benefits have been shown for other filled compositions of TFE resins.

It has been estimated that 20 to 25 percent of all power losses in farm equipment such as choppers, blowers and elevators, are attributable to friction. D. W. Richter (5) found that the static coefficient of friction for corn and grass silage on polished galvanized steel averaged 0.73 to 0.76, and that the sliding coefficient averaged 0.68 at speeds below 320 fpm. From Fig. 2, the coefficient of friction for these materials sliding on Teflon resins might be expected to be halved. The benefit of using fluorocarbon resins can be fully appreciated when this reduced friction is converted into reduced power requirements or improved equipment capacity.

Closely allied to frictional characteristics are wear and abrasion resistance. Parts fabricated from unfilled Teflon resins have good wear properties, and make excellent bearing and sealing surfaces for light loads at low rubbing velocities. Under heavier loads and higher rubbing velocities, filled compositions have proved superior to unmodified resins. Because wear depends upon so many variables, the wise designer usually will test new equipment at expected service conditions before making a production run.

Bearings

It is now generally recognized that the proper use of Teflon resins in bearings can result in significant savings to the owner, and will also permit more economical equipment design. For example, elimination of a grease fitting can result in a decrease in production costs as well as in reduced cost of operation.

These typical applications illustrate where bearings of TFE resins have proven their superiority:

Equipment exposed to weather or chemicals, typical in the case of farm equipment

Equipment for handling food and dairy products that must not be contaminated

In heavily loaded, slow-speed bearings where the oil tends to be squeezed out, such as might be found on tractors

In load-bearing locations that are liable to be overlooked

In oscillating and reciprocating applications when the lowest possible static friction is desired, such as on the rocker arms of a tractor or for carburetor shaft bearings

For bearings where the use of oil would collect abrasive dust.

Of course, there are some major considerations preceeding the decision to choose bearings of TFE resins.

The surface or rubbing speed, the load, the coefficient of friction, and the clearances are major factors in generating heat inside a bearing. For any bearing, the relationship between the rate of heat formation and removal is critical to bearing life, and bearings of Teflon are no exception. In fact, low thermal conductivity of TFE resins is an ob-

(Continued on page 825)

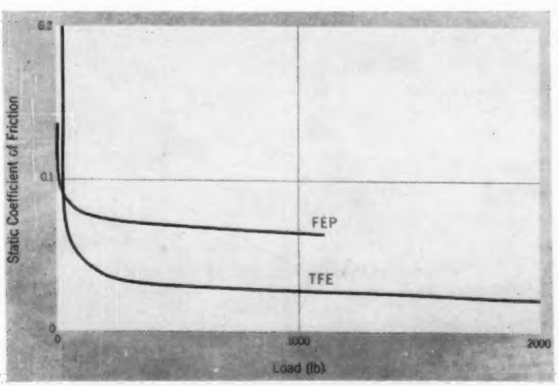


Fig. 1 The graph shows that, as the load on unreinforced Teflon resins is increased, the static coefficient of friction decreases significantly

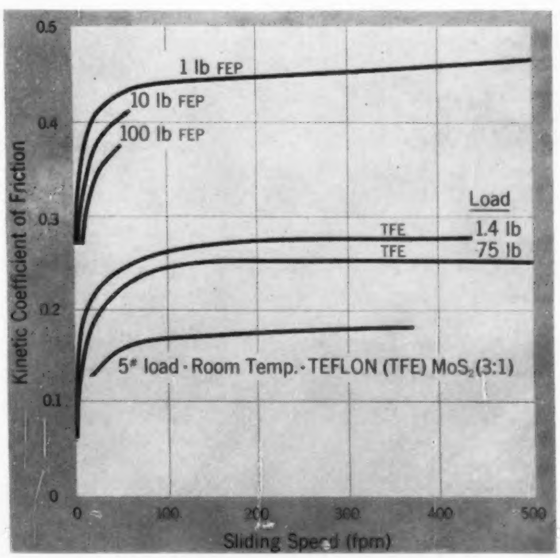


Fig. 2 Effect of speed on the coefficient of friction at different loads

Power Shift Transmission for Track-Type Tractors

Machine performance improved with less dependence on operator skill

George W. Eger and Charles A. Ramsel

BECAUSE of a desire to build machines that would meet customer needs, our company has tried to integrate the design of an engine, transmission and final drive into a tractor so that all components would fit the tractor. No tractor is changed to fit or make fit a standard component design, but rather all components are designed as a part of the tractor to provide acceptable tractor performance.

This standard of tractor performance has made it necessary for our company over the years to investigate many transmission designs. We have had pilot tractors utilizing direct-drive, constant-mesh transmission, direct-drive planetary configurations, full torque converter units, boosted power-shift controls and many others, in order to arrive at a satisfactory design. We believe that the power-shift transmission provided for our D8 tractors in mid-1959 satisfies our tractor-performance requirements.

The D8 tractor is a machine that weighs approximately 47,500 lb without equipment and 65,780 lb with bulldozer and ripper. The engine has a 235-hp rating at 1200 rpm at sea level; and we desire to operate this machine from 1 to 6.5 mph. This machine is found in all types of work. As a bulldozer it pioneers roads, builds dikes and dams, strips overburden, push loads scrapers, clears land; as a ripper in a good percentage of rock it will compete most favorably with blasting, and without the bulldozer and ripper it is utilized to pull plows, scrapers and logging arches. This machine is an industry standard in many fields and therefore it must be a versatile machine. The direct-drive, constant-mesh transmission has long been supreme in this size tractor. It is efficient, durable, simple to operate and repair. Combined with an oil flywheel clutch, it allows the operator to effectively use the inertia of the tractor in bulldozing, stumping and ripping. The constant-mesh transmission is, however, manually shifted and the operator, through a mechanical lever, moves the shifting collars. On a transmission for this size tractor, this is a tiring job and only the most skilled operator is able to do a fast, easy shift whenever he wants to under all circumstances. The job can be done by some people but it is not a universally easy job. For this reason over the years certain gears have become known as "bulldozing gear," "scraper gear," "pusher gear," etc. Operators also preset this speed selector before going up or down a grade because it was dangerous to attempt a shift on the grade. This of course was an inefficient method of operation from the standpoint of cycle time but the safest, surest way from the standpoint of life and limb.

The torque-converter drive has characteristics which distinguish it from a direct-drive gear. The torque-converter drive can accommodate a wider range of loads at good power output than the direct drive. It can be stalled without killing the engine. These characteristics, which are advantages under conditions of large and rapid-load variations, are achieved at the price of some reduction in peak horsepower and some increase in heat load and fuel consumption.

In the usual straight converter drive, the engine's speed under full throttle conditions does not change much while the tractor's load and speed are changing over a wide range. This has the effect of isolating the engine's inertia from the tractor. The tractor will tend to accelerate and decelerate more rapidly with changes in load.

In some applications, such as push-loading scrapers, the torque-converter drive is a great advantage. With it the tractor can push at high load and low speed while the scraper is loading and continue pushing, without interruption, after the loading is completed, giving the scraper a valuable boost in speed. This boost in speed can only be accomplished within the speed range of the torque converter since the constant-mesh transmission behind a torque converter cannot be shifted too readily to aid this boost over the entire speed range of the tractor.

In other applications, such as bulldozing, the torque converter's characteristics make it appear to considerably less advantage. The tractor will be less effective in those cases where impact, rather than a steady push, is needed as in dislodging a stump or a rock. The torque-converter tractor has a tendency to pick up speed rapidly when a heavy load is suddenly removed. This characteristic is very undesirable in some circumstances, such as bulldozing over the edge of a steep cliff or in very rocky soil.

The suitability of the torque converter for some applications, and its unsuitability for others, has compelled our company to offer, as options, torque-converter or direct-drive transmissions, on our D8 and D9 tractors.

The offering of options is not a particularly happy solution to the problem. The disadvantage, compared to a single, general-purpose transmission, include

The increased number of different replacement parts that have to be stocked by the company and by dealers

The lower production volume and consequent higher unit cost of parts not common to both models

The lack of complete versatility of either machine

Paper presented at the Annual Meeting of the American Society of Agricultural Engineers at Columbus, Ohio, June 1960, on a program arranged by the Power and Machinery Division.

The authors — GEORGE W. EGER and CHARLES A. RAMSEL — are, respectively, assistant chief engineer and general supervising engineer, Caterpillar Tractor Co., Peoria, Ill.

Acknowledgment: The authors acknowledge the assistance of R. O. Chambers, S. P. Nordling, and G. D. Rohweder in connection with the preparation of this paper.

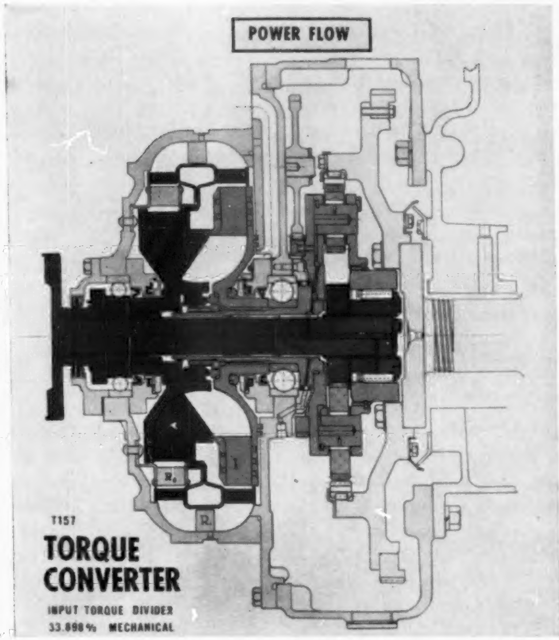


Fig. 1 The power-divider, torque-converter combination as used in the Caterpillar D8 power-shift transmission

The inevitable design compromises that must be made in order to accommodate both transmissions in the same basic machine.

The disadvantages of either type of drive are felt even in those applications where it is best suited. The torque-converter machine used for push loading would be a better machine if its power train were more efficient, and the direct-drive machine used for bulldozing would get more work done if it could accommodate a wider range of loads with good power output, without shifting.

A type of drive having characteristics intermediate between those of a straight torque converter and a direct drive would appear to be a very promising possibility for a general-purpose tractor drive.

The power-divider, torque-converter combination as developed for the D8 tractor with power-shift transmission has the following characteristics:

It permits the tractor to be stalled without killing the engine. The engine is, however, lugged rather heavily at stall, causing it to develop its maximum torque.

It accommodates a much wider range of loads at good power output than the direct drive without shifting. Combined with the power-shift planetary transmission, it rapidly adjusts to varying loads over the entire tractor speed range and is more versatile than the torque converter and constant-mesh transmission.

Its peak efficiency is higher than that of the straight torque converter.

Its speed range, at power output above 80 percent of rated engine power, is actually broader than that of the straight converter, due to the higher peak efficiency. Power output falls off faster outside the efficient range than with the straight converter. This may be considered an advantage, since it makes it easier for the operator to decide when to shift. Since shifting is very easy with the power-shift transmission, there is little need for extending the speed and torque range at low efficiencies.

Power loss, with the accompanying heat load, is reduced by about one-third over the entire range from stall to racing, as compared to the straight torque converter.

Load increases are reflected to the engine causing it to lug down under load, though not to the degree of the direct drive. This gives the tractor a large measure of the solid feel of the direct-drive tractor. The momentum of the engine is available to deliver impact forces where needed, and the tendency to surge ahead, when the load is suddenly removed, is greatly reduced.

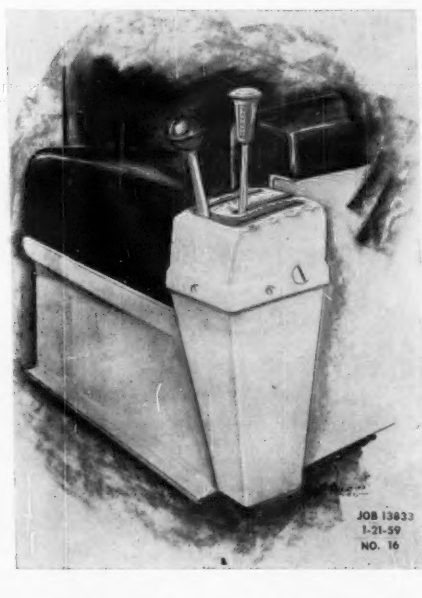


Fig. 2 *(Left)* Selector lever in neutral with safety knob in "safe" position

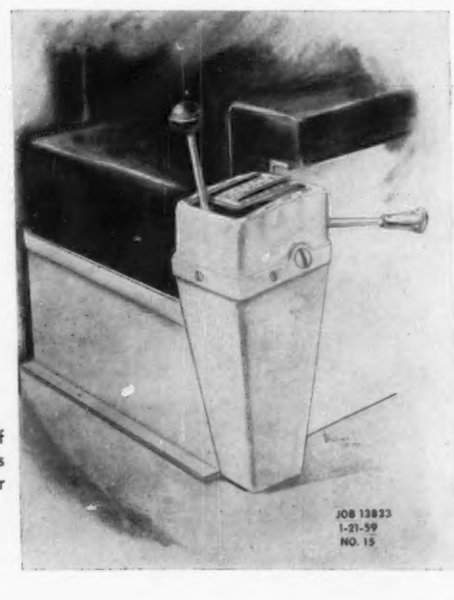


Fig. 3 *(Right)* Position of safety lever which permits moving of selector lever from neutral position

. . . Power Shift Transmission

The power-divider, torque-converter combination (Fig. 1) consists of a Twin Disc three-stage converter and a planetary gearset. This planetary set divides the engine's torque, about 66 percent being applied to the torque-converter impeller and then hydraulically to the turbine. This torque, in turn, is coupled to the transmission input along with the 34 percent of the engine torque which was transmitted mechanically.

In this way, a portion of the engine's power is transmitted mechanically to the transmission and is not subject to converter losses.

An increase in load causes the output shaft to slow down. This change in output speed acts through the planetary gears so as to make the converter impeller run faster relative to the engine. The impeller, running faster, absorbs more torque since its torque capacity varies in proportion to the square of its speed. The increased pump torque reflects more torque to the engine and to the output. In effect, the engine is forced to share the increased load with the converter turbine. The engine will then slow down to a point where its torque is in equilibrium with that of the converter and of the load.

The D8 power-shift transmission is an all-planetary transmission providing three forward and three reverse speeds. The forward ratios provide for a reduction, including transfer gears, of 2.23 in first, 1.275 in second, and 0.811 in third. Reverse speeds are 19 percent faster than forward speeds. The transmission speeds are selected manually by the operator by means of a control lever conveniently located near the operator's left-hand arm rest (Fig. 2). Dependable mechanical linkage connects the control lever to the hydraulic valves which control clutch engagement. A safety lever is provided to prevent accidental engagement of the transmission when the engine is running. There is in addition an automatic hydraulic safety valve which forces the lever to neutral when the engine is shut off. Fig. 2 shows the selector lever in neutral with safety knob in "safe" position. The selector lever cannot be moved from neutral position until the safety lever has been moved to the position shown in Fig. 3. The shift pattern is U-shaped providing neutral in forward position. This is also a safety precaution since it gives the operator one direction to move for neutral regardless of whether he is in a forward or reverse speed. Since the track-type tractor is the machine that constantly utilizes all speeds, this is an important consideration.

The transmission is mounted to the tractor bevel-gear case and is connected to the engine-converter assembly by means of a universal joint.

A pictorial cross section of the transmission in neutral is shown in Fig. 4. The center shaft is the input shaft with the universal joint flange on the right. The opposite end of this shaft is splined to provide a power take-off at converter output speed independent of the transmission speed. Transmission speeds are controlled by engaging two of the five clutches. The first clutch on the right is forward, the second clutch is reverse. Engagement of one of the three rear clutches together with one of the front clutches provides three speeds forward or reverse depending on whether No. 1 or No. 2 clutch is engaged. Power flows from the sun gears mounted on the input shaft into the carrier and out the sun-gear shaft surrounding the input shaft. A set of transfer gears are used to transfer the power to the bevel-pinion gear and into the final drive gear train of the tractor. In neutral the third clutch from the right is engaged. This is done to prevent carrier rotation when the transmission is in neutral with the engine operating.

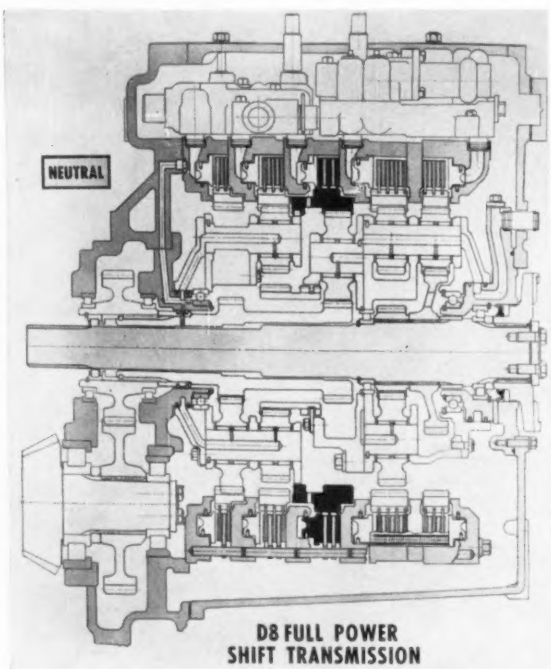


Fig. 4 Pictorial cross section of transmission in neutral

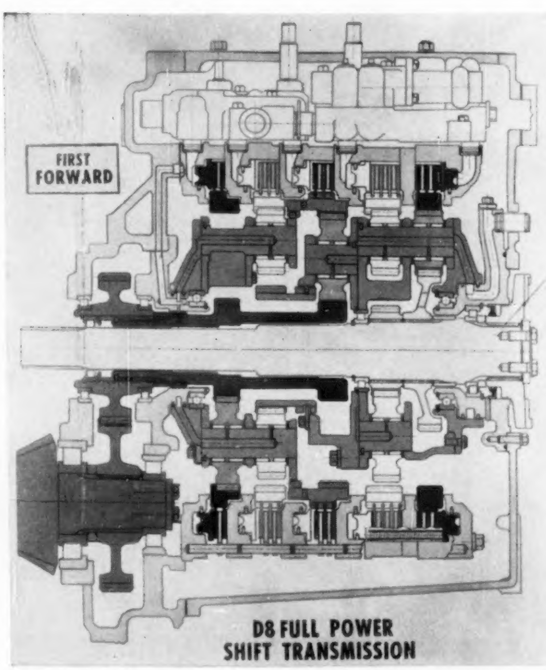


Fig. 5 Transmission in first speed forward

For convenience the clutches and planetary sets are numbered from right to left, one through five. Clutch No. 1 is the forward clutch, No. 2 is the reverse clutch, No. 3 is second speed, No. 4 is third speed, and No. 5 is first or low speed. The transmission in first speed forward is shown in Fig. 5. Clutches Nos. 1 and 5 are engaged. Engagement of No. 1 clutch causes the No. 1 ring gear to be stopped forcing the carrier to rotate. Engagement of the No. 5 clutch stops No. 5 ring gear and the reaction is taken into the sun gear, which transmits power into the upper transfer gear. It will be noted in first gear the power out is taken by both output sun gears which materially reduces the stress on these parts. The transmission in second speed forward has No. 1 and 3 clutches engaged, power out is through No. 3 planet set. The power flow in third speed forward is obtained by engaging clutches Nos. 1 and 4, and again power is taken out through No. 3 planet set but at a higher speed. Power flow in reverse is the same as forward in the rear portion of the transmission; the No. 2 clutch is engaged to reverse carrier rotation.

Fig. 6 illustrates the lubrication system. All planet bearings are lubricated with filtered oil, the oil being brought into the carriers under a pressure of about 12 psi. Oil is also sprayed on the inside diameters of the clutches for cooling. The lubricating oil is drained by gravity into the bevel-gear compartment where it is picked up by the transmission pump for recirculation in the system.

This transmission was designed to provide a simple rugged unit that is easy to assemble with standard tools and requires no adjustments within the transmission package. The entire transmission can be disassembled and assembled with a wrench to fit a ½-in. bolt and a wrench to fit a ⅜-in. bolt.

All gears in the transmission are straight spur. The planet gears are mounted on roller bearings and, as mentioned before, are pressure lubricated. The planet carriers are cast of ductile iron. Clutch housings, pistons, and transmission case are high-strength cast iron. Clutch pistons are sealed by means of cast-iron piston rings. The clutch disks, 21 in. in diameter, are sintered bronze bonded to a steel core and splined to the ring gears.

The transmission fully assembled, including controls, is 23¼ in. from mounting face to universal joint flange; the transmission case is 26⅜ in. wide, and 35½ in. high. Forty-three gallons of oil are required for servicing. The weight of the unit fully assembled is 2040 lb.

The operator controls the D8 power-shift transmission with a single lever in a U-shift pattern. Sideways motion of the control lever provides directional control while fore-and-aft motion gives desired speed selection. Neutral is located forward, at the bottom of the U, to allow the operator to get neutral merely by moving the control lever forward as far as it can go. This is a safety feature because it allows the operator to obtain neutral without a visual observation to determine what position the control lever is in, either forward or reverse. Detents are provided inside the transmission case on the levers which move the selector spools. They provide the feel necessary for the operator to know when he has completed the shift without looking at the lever position.

Operation of the power-shift transmission is achieved by hydraulically actuating the transmission clutches. Power for the hydraulic system is obtained from a vane pump driven from the torque-converter, planetary-gear train carrier. This drive location provides a more nearly constant speed, and, therefore, a consistent pump displacement from engine high idle to stall speed. A full-flow filter is placed in the pump outlet line between the pump and the transmission controls. After leaving the controls, the oil flow is used for lubrication of the transmission.

Transmission of power through the transmission is achieved by actuating one of the speed clutches and one of the directional clutches at any one time. This is accomplished by the routing of oil through a speed selector spool for the speed clutches and a dump spool and the directional spool for the directional clutches. These hydraulic spool valves are part of the control package. This hydraulic control is the heart of the transmission, without it the transmission would not have the same quality performance, in fact, the transmission would cease to function (Fig. 7). The speed selector spool and the dump spool are connected mechanically through linkage to be moved when the control lever is moved fore or aft between neutral and third. The directional selector spool is also connected by linkage to the control lever to be moved when the control lever is moved sideways between forward and reverse.

The speed-selector spool engages one of the speed clutches in each of its four longitudinal positions, namely, neutral, first, second, and third. To make the shift out of neutral as smooth as possible, this spool engages the intermediate clutch (No. 3) in neutral to keep some of the transmission's rotating parts stationary. In first speed, this spool engages, the low-speed clutch (No. 5). In second speed, it engages the intermediate-speed clutch (No. 3), and in third it engages the high-speed clutch (No. 4).

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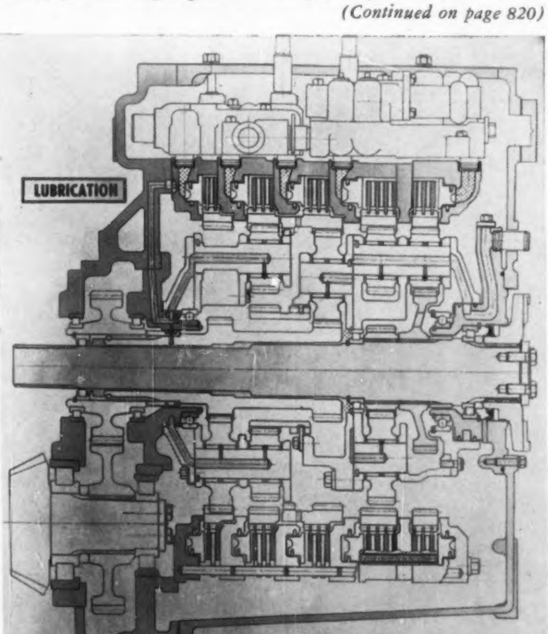

Fig. 6 The lubrication system of the D8 transmission

Performance of a Pneumatic Feed-Conveying System

H. B. Puckett
Member ASAE

Automatic system of preparation and distribution required for high efficiency

THE need for automatic equipment to handle small, time-consuming jobs about the farmstead is particularly acute in livestock production. Feed handling is one of these time-consuming chores. A reliable, completely automatic system of feed preparation and distribution should find a ready market.

An important component—automatic equipment for the preparation of a feed ration—is available. Auger conveyors and high-volume pneumatic conveyors are used for distribution of prepared feeds to the feeding locations, and many adaptations of the auger have been made to effect automatic feed distribution. These mechanical feed conveyors work well within their limitations in an automatic system, and their possibilities should not be overlooked. The main disadvantage of an auger conveyor in an automatic feed-distribution system is the time lag between induction of the material into the conveyor and its discharge at the feeding point. (The rate of travel of material in the auger is about 25 fpm at 100 rpm.) This time lag makes it time-consuming to clean out the conveyor when various rations must not be mixed.

The high-volume, low-pressure pneumatic conveyor has been used to distribute feed from an automatic feed-preparation unit. An advantage of this type of pneumatic conveyor system is that equipment requiring periodic service is in one location and easily maintained. The main disadvantage is that the high volume of air required creates excessive dust at the discharge point. In addition, large pipe must be installed and used with care.

The power for conveying material in a pneumatic system is determined by two factors: the volume of air moved and the pressure that must be applied to the system. It is reasonable to assume that, if less air is moved at higher pressures, more work can be done for a given amount of energy because less work will be required to move the air mass.

Pneumatic conveying may be divided into three types as follows:

1 The first type is high-volume, low-pressure conveying. Such systems use a centrifugal blower or an impeller-type blower. Material is generally introduced into the system through the blower. However, because of possible damage to the conveyed material by impaction with the blower-wheel vanes, some systems use a venturi to draw the material into the high-velocity airstream. The use of a venturi feeder reduces damages to seeds and prevents size reduction.

2 The second type is the low-volume, medium-pressure system, arbitrarily limited here to systems employing not more than 20 lb of air pressure per square inch. This system is growing in popularity for many conveying functions. Its main advantage is the use of small pipe. Industrial systems range from 1½ to 4-in. pipe. These systems use a rotary air lock or a plugged-auger feeder. The rotary air lock is the most common method of placing material into the conveying line. Air pressure is supplied in most systems by a rotary air pump of the double-piston rotary type, commonly known as a "roots" blower. Other systems use the rotary vane-type compressor, which in the author's experience is more efficient for supplying the air pressure.

3 The third type is the low-volume, high-pressure system (above 20 psi). It is used for high-density and long-distance conveying of materials like cement or other finely divided materials that will retain entrained air and approach a state of fluidization. (It is in this state that granular materials behave as liquids.)

The weight of material conveyed per pound of air is sometimes used to describe the performance of a pneumatic conveying system. This figure will vary from about three-to-one in the high-volume, low-pressure systems to three hundred-to-one in the low-volume, high-pressure systems. The length of a high-volume, low-pressure system is limited to approximately 300 ft because of limited air pressure from the blower. For long-distance conveying, the solids-to-air ratio must be reduced to prevent the pressure drop from exceeding the fan pressure limit.

In many ways the low-volume, medium-pressure system behaves the same as the low-pressure system, except that more air pressure is available. In both systems, the minimum air velocity for satisfactory long-distance conveying (more than 100 ft) is approximately 3,500 fpm in the conveying pipe.

A solids-to-air ratio of about twenty-to-one is normally expected; it can be greater for short distances and will be less for long distances. The maximum pressure available from the compressor limits distance and solids-to-air ratio.

Air-conveying systems that use pressures measurable in pounds per square inch rather than in inches of water are often referred to as fluidization systems. For many of the systems, this term is a misnomer. Fluidization implies that the solids will behave as a liquid and that they may be piped in the same way as a fluid. In most medium-pressure pneumatic conveying systems this is not true. The conveyed

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material does not retain the entrained air for more than a few feet from the point of injection. From this point, about 20 to 25 ft from the point of injection, the system will behave in much the same way as the low-pressure, high-volume conveying systems, except that fewer pounds of air are used to accomplish the same work. A greater density of feed material is present within a given pipe section of a medium-pressure system than of a low-pressure system. The conveying velocities are approximately the same for satisfactory continuous conveying. This air velocity is approximately 3,500 fpm without material in the conveying pipe. Since this is a minimum velocity, it normally follows that the smallest diameter should be used that will satisfactorily convey the material with the pressure available, to reduce the quantity of air that must be handled. As the length of the conveying system increases, the solids-to-air ratio is reduced. This is done to prevent an excessive pressure drop. The compressors used in medium-pressure conveying are limited to approximately 20 lb per square inch.

Medium-pressure pneumatic conveying systems are well suited for automatic feed distribution because of the ease with which they can be controlled and the feed routed from one loading point to any of several discharge locations. Valving and piping systems have been developed for commercial applications, and similar equipment could be used in a fully automatic feed-distribution system for the farm. The advantages of automatic control, the very small amount of dust at the discharge location, and the ease with which such a system can be controlled make it desirable.

Laboratory tests were started to determine the effects of the following variables on system pressure requirements for satisfactory conveying:

Diameter of conveying pipe

Length of system

Volume or mass of air used

Rate of conveying

Type of material conveyed

Elbow radius

Orientation of elbows

Location of elbows in pipe (distance from inlet)

Direction of conveying.

The first tests were made with a rotary-valve feeder (also known as a vacuum dropper wheel) used to convey cotton seed. One and one-half-inch polyethelene pipe was used as the conveying pipe. Four tons of various feed materials per hour were conveyed through the pipe. The pressure requirements for conveying a given weight of oats, shelled corn, soybean oilmeal, or ground shelled corn and soybean meal varied slightly.

Because a rotary feeder loses the displacement air, an auger feeder was tried. A 2½-in. diameter screw in a tight-fitting tube was powered from the bottom to avoid air-seal problems around the power shaft in the mixing chamber. In order to form a core of feed material which would serve as an air seal at the upper end of the conveying tube, the auger was discontinued 3 in. from the end of the auger casing. This is referred to as the plugged-auger feeder. The auger was inclined 30 deg to cause it to operate with a full tube and thus lessen the possibility of a "blowout."

The plugged-auger feeder worked well if sufficient care was used in starting it. The plug had to be formed before air pressure was applied to the conveying line. No satisfactory system of automatic starting could be devised, nor could adequate protection against blowouts be provided. Either of these faults was sufficient to preclude its use in an automatic feed-conveying system.

Testing was continued using the rotary feeder to charge the conveying line. Early tests compared the effect of pipe

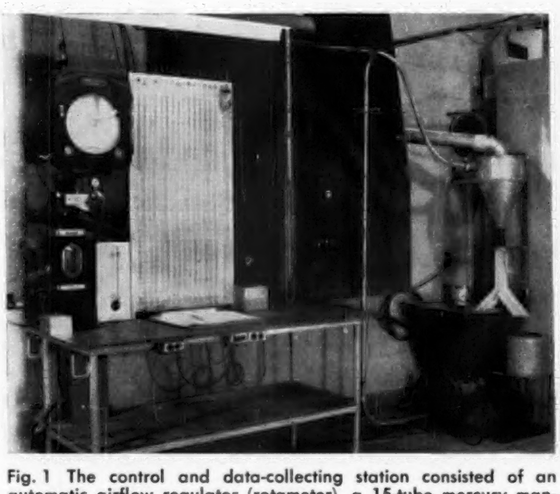

Fig. 1 The control and data-collecting station consisted of an automatic airflow regulator (rotameter), a 15-tube mercury manometer, an interval timer switch, a temperature indicator, and operating controls for the electrically powered equipment *(upper left)*. The material used in conveyor tests is stored in the hopper above the rotary airlock valve (feeder) and is returned to the hopper by the conveying line. The "Y" valve is controlled by an interval timer and is used to collect weight samples. The conveying rate is controlled by the adjustable speed motor *(lower right)*

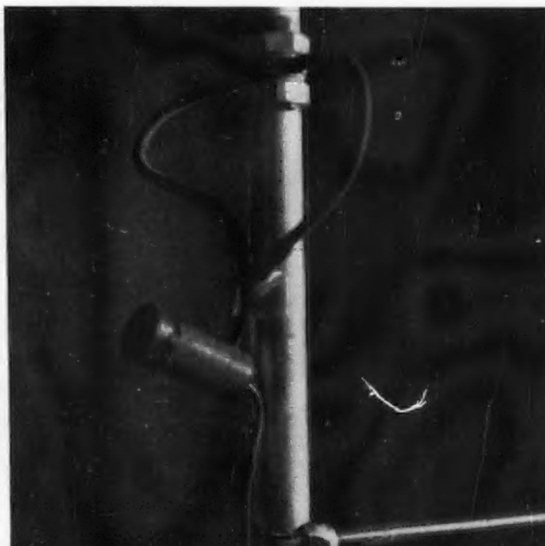

Fig. 2 Static pressure measurements were made with this double-pressure tap. Two taps were used to get an average static-pressure measurement across the pipe. The small dust collector prevented plugging of the long pressure tubes

. . . Pneumatic Feed-Conveying System

diameter on conveying rate. The rate obtained for 1½-in. diameter pipe was about 8,000 lb per hour. This rate was not an absolute maximum but was the limit of the valve and air compressor used. The one-inch pipe that was used conveyed 4,000 lb per hour under similar conditions. The one-inch pipe required about 2 psi per 100 ft of pipe and 20 cfm to convey 2,000 lb of material per hour. This rate is adequate for most farm feed-conveying needs. All subsequent tests were conducted with one-in-diameter pipe.

Plastic pipe was eliminated from the testing program for two reasons: control of static electricity was difficult, and the plastic eroded quickly. Thin-wall steel tubing or aluminum tubing was used in all subsequent tests.

Tests were conducted to establish the relation of conveying rate, mass of air used, and length of straight horizontal one-inch, inside-diameter pipe on pressure drop. The objective of these tests was to derive an empirical formula that would express the pressure drop in any length system, within reasonable limits for conveying rate and air mass flow. At this time a satisfactory analysis has not been accomplished that will permit this relationship to be projected beyond the limits of the laboratory tests. New analyses are being conducted to permit extension of these data beyond tests limits.

The tests were conducted within the following limits:

Diameter of conveying pipe	—1 in.
Length of system	—90 ft
Mass flow of air	—15, 20, 25 and 30 strd cfm
Rate of conveying	—400—2,000 lb per hour in 200-lb steps
Type of material conveyed	—whole grains and ground feed (soybean oilmeal used in most tests)
Elbow radius	—7, 12, and 18 in.
Orientation of elbows	—up, down, horizontal
Location of elbows	—near inlet, near outlet, and middle of line
Direction of conveying	—vertical (up and down) and horizontal

Equipment used to gather the data is shown in Figs. 1 and 2.

The principal variation of the independent variables, length, conveying rate, and air-mass flow, is linear. The results for soybean oil meal are given in Fig. 3.

Fig. 3

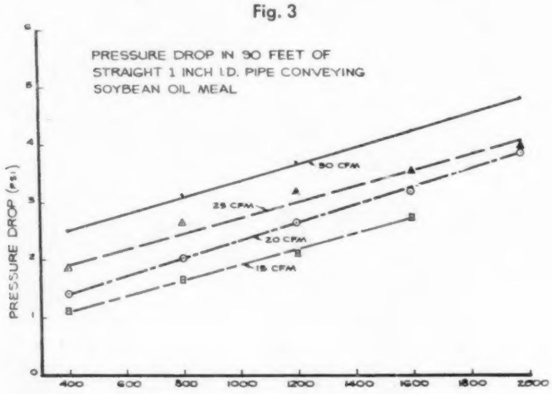

TABLE 1. PRESSURE DROP IN VERTICAL ONE-INCH I.D. PIPE-CONVEYING SOYBEAN OILMEAL

Average Pressure Drop per 10 ft of Pipe

Airflow, cfm	Feed, pounds per hour	Average up	Average down
15	400	0.165	0.11
	800	0.320	0.16
	1200	0.450	0.16
	1600	0.525	0.19
	2000	0.635	0.20
20	400	0.240	0.14
	800	0.385	0.19
	1200	0.510	0.29
	1600	0.680	0.34
	2000	0.790	0.36
25	400	0.295	0.20
	800	0.455	0.30
	1200	0.615	0.36
	1600	0.745	0.43
	2000	0.890	0.45
30	400	0.310	0.23
	800	0.515	0.35
	1200	0.700	0.47
	1600	0.845	0.53
	2000	0.940	0.64

Ratio of pressure drop "up" to pressure drop "down": 1.8:1.

Variance between pressure drop per 10 ft for flow in same direction was not significant.

A graph of the results of placing 90-deg elbows in the conveying line and using 25 cfm is given in Fig. 4. Other tests conducted with elbows showed an increase in pressure drop across the elbow the farther the elbow was located from the inlet. Also, elbows that were directed downward had a higher pressure drop than those in the horizontal plane or those pointed upward. This difference was slight.

The pressure drop in vertical tests is given in Table 1. The results of the tests show that 1.8 times as much pressure is required to move material vertically upward as downward.

Without completion of a satisfactory empirical formula, the following is the best estimate of pressure drop for a one-inch pipe, medium-pressure conveying system handling 1,000 to 1,200 lb of material per hour with 25 cfm:

Fig. 4

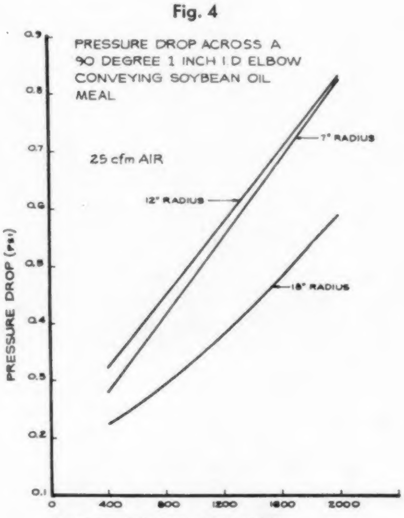

Fig. 5 This automatic feed preparation and distribution system mixes as many as four out of seven possible ingredients automatically to form a complete ration. A medium-pressure pneumatic conveyor transports the feed as it is ground to any one of four discharge points. The distribution control panel is on the wall at the right of the photo. The power control panel is on the mill

1.5 - 2.0	psi	per 100 ft of system length
0.4 - 0.5	psi	per 90-deg 7-in. radius elbow
1.0	psi	for feeder valve and entrance losses
0.3	psi	for flow diverter valve, straight side
0.6	psi	for flow diverter valve, branch side.

Compilation of the above factors for the most distant point will in most instances be adequate for the remainder of the system.

The first field installation of this system was at the site of the automatic hog-feeding system, which has been described in AGRICULTURAL ENGINEERING 39:11, 692-696, 1958. This feeding system has been expanded and now includes three locations with a maximum distance of 190 ft from mill to feeding point. It has been in continuous satisfactory service for approximately two years. The second and most recent installation of an automatic medium-pressure, pneumatic feed-conveying system was on the Frye turkey and poultry farm in Peoria County, Ill. (Fig. 5).

The system was installed on the Frye farm during the first week of June, 1959, and has been in continuous operation since that date. Only two major breakdowns have been experienced. In each case it was a failure of the pump. A vane-type rotary air compressor served as the primary source of compressed air for the conveying system (Fig. 6). First failure was caused by excessive pressure on the pump. The second failure was due to a blockback of feed from the rotary valve into the pump at the end of a conveying period. The conveying line would sometimes be under high pressure at the time of shutdown. This pressure blew feed from the rotary valve into the air compressor. The close tolerance of the compressor could not accommodate even a small amount of solid material between the housing and the rotor, the result being broken pump vanes. This difficulty was corrected by the addition of an in-line filter and relocation of the swinging check valve between the rotary airlock and the air compressor.

The pressure relief valve on the vane-type pump was set for 12 psi. The maximum continuous pressure recommended by the manufacturer is 10 psi. The additional 2 psi were needed to operate the pressure switch controlling the purging air valve. This was an infrequent operation and could not last for more than two minutes at any one time.

Another trouble spot in the Frye system was the pinch valve used to control the flow of feed from the main line into the branch line (Fig. 7). Each pinch valve consists of a metal tube with a collapsible rubber inner liner. Compressed air is injected between the liner and the outer casing, causing the liner to collapse and plug the line. Each flow diverter consists of two of these valves, which are actuated by a four-way solenoid. In normal operation, one

Fig. 6 The medium-pressure pneumatic conveyor package is mounted beneath the automatic mill. It consists of a rotary airlock, a vane-type dry air compressor, the compressor motor, and the drive for the airlock

Fig. 7 Valves suitable for automatic operation control the direction of feed movement. This is a three-way pinch valve, air operated and electrically controlled

. . . Pneumatic Feed-Conveying System

of the valves is always closed. The liners failed because of excessive wear at the downstream end. The construction of the valve was such that a small restriction was formed at the downstream end by the liner. The feed material eroded this restriction and caused the liner to fail in about one month. This problem has not been satisfactorily overcome at this time; however, the life of valves has been increased by releasing the control air pressure when the valves are not in use. The expected life is now about three months. This is still too short. An improved liner has been constructed and is expected to materially increase the valve life.

When the control air pressure was released, an unforeseen tendency for the line to plug developed. Originally the air was released very rapidly, causing both sides of the flow diverter to open quickly. Both of the valves were open before the conveying compressor had completely stopped and while pressure was still on the line. Feed material was blown through the straight valve, and the air propelling the feed was dissipated through the branch valve, carrying a little feed into the branch line. The feed blown through the straight side of each flow diverter at shutdown soon resulted in a plugged line which had to be manually cleaned. This has been overcome by restricting the control-air pressure release so that the valves remain in operation long enough for the compressor to stop and all conveying line pressure to be dissipated through only one side of each diverter. In this way the solids are better distributed throughout the length of the pipe and are not apt to cause plugging. Proper choice of the side of the valve to be normally open will further reduce the chance of plugging.

The control system has been designed in two sections. The power-control section contains the relays and safety devices necessary to operate the mill and the high-pressure pneumatic conveyor. They are located in one panel and are attached to the mill for ease of wiring (Fig. 5). The distribution panel controls the operation of the system. It consists of several subassemblies (Fig. 8).

The power-control panel consists of motor starters, overload relays, interlocks, and time-delay circuits, and a warning circuit that is activated if the system fails to perform properly. The safety devices incorporated in this panel are motor-overload relays, a time delay which prevents the starting of the mill motor until the compressor has started and purged the line, and conveying-line and control air-pressure switches. If the mill relay remains open for two minutes (adjustable), an interlock between the mill relay and the warning circuit will shut the system off and activate the warning circuit. The mill relay can be opened by the overload relays, the feed-meter safety switch (which opens if any ingredient fails to flow to the metering section), too high a line pressure, or too low a control air pressure for the diverter valves. For these controls to operate, there must be a demand from the distribution control panel for the system to be in operation.

The distribution control panel is expandable. It consists of the necessary controls for each feeding location. Each position control subassembly is constructed in modular form. In addition, there is a manual-automatic subpanel which contains the selector switches necessary to transfer operation from remote-control, automatic operation to manual operation controlled at the panel board.

A summary of the medium-pressure pneumatic conveyor performance in the Frye installation and that in the automatic hog-feeding unit is given in Tables 2 and 3.

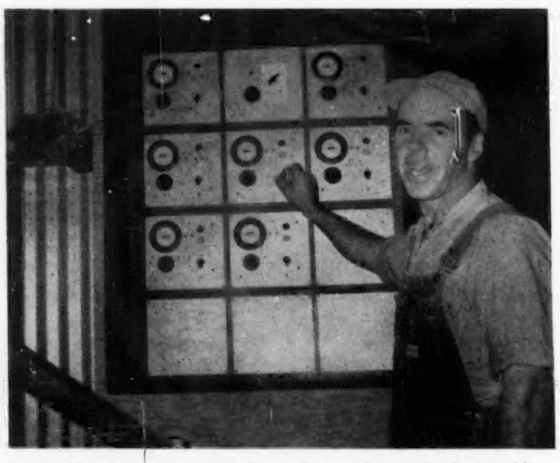

Fig. 8 The distribution-control panel is made up of subassemblies, one for each discharge location (this panel designed for eleven), and one automatic-manual control subassembly

TABLE 2. SAMPLE OF MEDIUM-PRESSURE PNEUMATIC CONVEYOR DATA

Warren Frye Turkey Farm

		Discharge location No. 4 Growing chicks		
Ration, percent	Corn	81.25		
	Premix	15.0		
	Oats	0.0		
	S.B. Meal	3.75		
Feed conveyed	1 lb per hr	1148		
Grinder power	Kw	1.88		
Grinder, kwhr/cwt/hr	Kwhr	.164		
Pump	Rpm	1530		
Airflow	Cfm	32.20		
Pipe length	Ft	365		
Discharge height	Ft	6		
		Av.	Max.	Min.
Pump power	Kw	2.07	2.15	1.97
Pump, kwhr/cwt/hr/100 ft	Kwhr	.0494	.0513	.0470
Line pressure	Psig	6.60	6.80	6.30
Psig/cwt/hr/100 ft	Psig	.157	.172	.142
Pressure drop across valve				
Straight through	V_2	.3375	.40	.30
	V_3	.2875	.45	.10
Branch	V_4	.550	.65	.45

TABLE 3. SAMPLE OF MEDIUM-PRESSURE PNEUMATIC CONVEYING DATA FOR AUTOMATIC HOG FEEDING SYSTEM

		No. 2 East feeder
Ration, percent	Corn	82
	Supplement	18
Feed conveyed	Lb per hr	900
Grinder power	Kw	1.76
Grinder, kwhr/cwt/hr	Kwhr	.196
Pump power	Kw	1.38
Pump speed	Rpm	1008
Pump, kwhr/cwt/hr/100 ft	Kwhr	.0807
Airflow	Cfm	24.5
Pipe length	Ft	190
Line pressure	Psig	3.75
Psig/cwt/hr/100 ft	Psig	.219
Pressure drop across valve		
Straight through		.20
Branch		.30

Need for Graduate Study in Agricultural Engineering

Rapidly advancing technology focuses attention on improved training of leaders

L. L. Boyd
Member ASAE

MORE competent young agricultural engineers should be undertaking graduate study. The prestige and continued advancement of the profession depends on the development of leaders having the proper blending of experience with a broad and penetrating theoretical training. Great strides are being made in undergraduate education. Curriculums are being upgraded and otherwise improved. High school seniors enter college better prepared than in the past. However, these improvements are not sufficient to produce the kind of leaders needed for our rapidly advancing technology.

No longer is advanced study necessary only for those employed in the field of public service. Industry also needs men whose creative and leadership talents have been stimulated and developed by rigorous and challenging graduate study. An awareness of this has reached varying stages within industry. Many companies already offer higher starting salaries to men with graduate degrees. All expect men with graduate degrees to develop more rapidly than those without them. Thus men with graduate degrees are more likely to be given additional opportunities to utilize their advanced training.

Greater effort must be made to encourage advanced study. *Universities must recruit for graduate study just as vigorously as industry does for its needs.* Undergraduates need to be made aware of the importance of graduate study as early as their freshman year and frequently thereafter. Competent students should be encouraged to elect courses that will stimulate their interest in graduate study. Additional encouragement should come from other universities through an exchange of names and addresses of the best students who should be undertaking graduate study.

Industry's Role

Employment representatives should encourage the most competent young engineers to study for graduate degrees prior to taking positions in industry. They need to be assured that they will receive higher salaries and have more opportunities for advancement with graduate training than without it. In addition, industry should make an effort to work out leave programs for graduate study for their exceptional young engineers who have had none. Cooperative, extension and industry graduate programs all are helpful, but full-time uninterrupted study is preferable (3)*. The close association with other full-time scholars is inspirational and the exchange of ideas among them encourages creativity.

Industry already has done much to promote graduate study through grants. It has also been generous in supplying equipment for use and study. These practices should be continued and expanded. However, it is even more important that industry help guide the competent students into graduate study.

Standards of Competency

Minimum standards of competency for each graduate degree are needed if the degrees are to be meaningful. The M.S. and the Ph.D. degrees granted at one university should be somewhat comparable to those from another. Such standards should not and need not restrict the desired flexibility of planning programs to meet the needs and interests of the individual student. However, they should indicate that the student *(a)* has successfully completed at least a minimum amount of formal study of graduate level with which he is sufficiently conversant to be able to utilize in his future work, *(b)* has acquired and demonstrated the ability to select and conduct research independently, and *(c)* can express himself clearly, concisely and accurately in both oral and written form.

Several steps to establish more uniform standards already have been taken by both ASAE and ASEE (1, 2, 3). The following suggestions and recommendations reflect some of the more recent developments:

Program Formulation

Formal study should comprise between 50 and 75 percent of the graduate program. Suggested approximate distributions of formal study and research for both the M.S. and the Ph.D. degrees are given in Table 1. Formal study, in general, should include primarily courses emphasizing ad-

*Numbers in parentheses refer to the appended references.

TABLE 1. SUGGESTED APPROXIMATE DISTRIBUTION OF FORMAL STUDY AND RESEARCH FOR M.S. AND PH.D. PROGRAMS IN AGRICULTURAL ENGINEERING

	Master of Science			Doctor of Philosophy		
Area and subarea	Time (Percent)	Semester hours	Quarter hours	Time (Percent)	Semester hours	Quarter hours
Formal study						
Major courses	30	9	13	20	18	27
Minor courses	40	12	18	20	18	27
Minor courses				20	18	27
Research	30	9	14	40	36	54
	100	30	45	100	90	135

Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Amherst, Mass., August 1960. (Revised and condensed.)

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Acknowledgment: The author expresses his appreciation to many members of the American Society of Agricultural Engineers and to others who have in various ways contributed to the preparation of this paper.

. . . Need for Graduate Study

vanced basic principles. The competent student with a solid background should have little difficulty making applications within his area of interest. Semi-formal study such as special problems and seminars should be included to give an opportunity for making applications and to encourage self-education, the real key to continued development throughout life. Formal study should support the thesis research, but more important, it should provide the basic background for use in solving the problems of the intended career.

Minor Areas

Although the educational philosophy of graduate schools varies, when possible, engineers should take their minors in engineering rather than in science if rigorous courses are offered in both. For example, advanced thermodynamics might be taken in either mechanical engineering or physics. It would seem wise to take the minors in the strongest departments within the university. Minors in engineering mechanics should be encouraged because of the basic nature of the offerings. Mathematics also is an excellent minor, but some of the work tends to be abstract. Engineers need to be creative and association with practical approaches in conjunction with the theoretical helps to develop creativeness. Minors in the social sciences, biological sciences, statistics or education should be permitted, but not encouraged. Needed work in these areas can be obtained by self-study, as collateral work, or, if of graduate level, integrated into the rest of the program.

Graduate Courses in Agricultural Engineering

Much difference of opinion exists regarding the desirability and necessity of graduate courses in agricultural engineering. The prestige of offering graduate courses will be recognized only if they are of truly graduate level and not a composite of advanced undergraduate courses from other fields. Also, there seems to be little justification for duplicating graduate offerings of other fields. More of the desired prestige can be gained through the close association of agricultural engineering graduate students with those of other disciplines in the same courses. Some graduate courses should be designed to fill void areas in which graduate courses are not offered elsewhere. An example is a course in research techniques that would implement and make more meaningful the experience of the thesis research. Specialized courses should be offered when the material can no longer be presented effectively semiformally. However, specialized courses can not be maintained at the graduate level if students of all specializations are required to take them. Agricultural engineering courses probably should not comprise more than 50 percent of the major course work. Such a limitation permits the addition of desirable courses from fields other than the minors that otherwise could not be included.

Formal Study Recommendations

Specific course requirements for the M.S. degree should include a minimum of three semester hours in mathematics beyond elementary differential equations, such as advanced engineering mathematics or higher calculus. Statistics should be included if possible, but it should not be substituted for the mathematics. At least one and preferably more of the minor courses should be of graduate level. No minor course should be less than third year level for undergraduates majoring in that area. Superior grades should be required for graduate credit to be granted for any undergraduate course. At least one-half of all formal study for the M.S., excluding collateral courses, should be of graduate level.

A Ph.D. degree program should include a minimum nine semester hours in mathematics beyond elementary differential equations, of which six semester hours should be either advanced engineering mathematics or higher calculus. No less than six semester hours of statistics should be included. The Ph.D. degree program also should include such basic courses as advanced strength of materials, advanced dynamics, vibrations, stress analysis, similitude, theory of elasticity, plasticity, plates and shells, advanced thermodynamics, advanced heat transfer, temperature-measuring instruments, advanced fluid mechanics, hydraulic measurements, atomic and nuclear physics, quantum mechanics, etc. At least two-thirds of all formal study for the Ph.D. degree should be of graduate level.

Research and Thesis

Considerable emphasis should be placed on the research and the thesis as previously indicated. Admittedly, all graduates will not carry on research in their jobs, but they need to be able to interpret thoroughly the results of research regardless of their position. The advancement of our profession depends as much, and perhaps more, on the utilization as on the performance of research. Therefore, the thesis research should provide the student with experience in *(a)* evaluating and selecting problems of agricultural and engineering significance on which research is needed, *(b)* development of analytical and experimental approaches to the solution of the problem(s), *(c)* development and/or selection of experimental equipment and its procurement, *(d)* collection of data in a systematic way that will lead to thorough, orderly and accurate analysis, *(e)* analysis of data including conclusions and comparison with theory and similar studies if any, and *(f)* the presentation and defense of the work.

A thorough literary review should be emphasized to eliminate unnecessary duplication of effort and to provide background. Statistics should be used both for experimental design and error analysis. A major portion of the research time should be spent in planning for the collection of data and in its analysis with a minor portion for the actual collection. The thesis should be written clearly, concisely and accurately.

Teaching Experience

All will agree that it is important for the graduate student to learn to express himself well. The thesis gives experience in written form. Teaching experience helps to develop oral ability. Teaching also develops depth of subject matter and confidence in addition to encouraging self-study. Graduate students should not be used as inexpensive teaching help; the only purpose of teaching should be their development. At Cornell, graduate students are asked to assist with teaching approximately 15 hours per week during one term each year. This gives sufficient experience without delaying their programs.

Time Requirements

The expediting of graduate programs has been recommended by many (3, 4). Graduate students should complete their programs as rapidly as possible so that they can begin productive effort. Our best students should finish the Ph.D. requirement in not more than three and one-half calendar years and preferably in three. The M.S. should be finished in no more than one and one-half years with several doing it in less. Because the M.S. is difficult to complete in one year as presently constituted, perhaps it would be advantageous if it were extended from a "1/3 Ph.D." degree to a "1/2 Ph.D." degree. This would permit the student to become better trained in research techniques.

Foreign Languages

Foreign language proficiency should not be de-emphasized. Research in other languages needs to be reviewed just as thoroughly as that in English. Languages are receiving increased attention in elementary, high school and undergraduate education. Students of the future will have little difficulty with foreign languages and will make use of them. Students of the present should try to make up their deficiencies in language as well and as rapidly as possible. If the M.S. program is lengthened as suggested, one of the languages should be required. This will ease the transition into the Ph.D. program.

Admission Requirements

It has been suggested (1) that at least 25 percent of the undergraduates should be undertaking graduate study. We should recruit most vigorously in the top 25 percent of each class but also should encourage others. Class standing in the college of engineering is usually more indicative of ability than grade averages which vary from one school to another. Admission should be based to a great extent on the results of the graduate record examinations which all applicants should be asked to take. Rapid improvement, part-time employment and other factors must be recognized, but any competent student should do well in the graduate record examinations.

Financial Support for Graduate Students

Potential graduate students must be made aware of the many possible ways of financing their study such as scholarships, fellowships, assistantships, etc. Superior agricultural engineering students have been granted a few of the special scholarship awards such as those from the National Science Foundation. More should be encouraged to apply. The important point is that interested and qualified students, regardless of financial position, can find ways to underwrite their advance study expenses.

Administration

Good graduate programs require close supervision, particularly as the number of students increases. This can be accomplished effectively through a graduate program supervisor. The supervisor serves as a liaison man between the department and the graduate school, takes charge of recruitment, makes teaching assignments and takes care of many other details. Committee chairmen still formulate the graduate programs of the students and direct the work. Chairmen should strongly encourage and in some instances require the student to submit regular reports on his work. These serve as a record and indication of progress and are very useful in the preparation of the thesis. Chairmen also should require the student to prepare an article for publication prior to the granting of the degree. Most committees should include two members from the major department. Such an arrangement provides training for inexperienced staff members for chairmanship duties. It also provides additional guidance for the student and continuity of committee if the chairman should leave the university.

Summary

The following needs and opportunities should be re-emphasized:

(a) Universities must recruit vigorously with industry's assistance more of the competent students for graduate study

(b) Minimum standards of competency for graduate degrees should be established

(c) Graduate students should be selected carefully and should complete their programs promptly

(d) Graduate courses in agricultural engineering should be developed, but only with much forethought and care

(e) Our profession has the opportunity and the responsibility to thoroughly train the leaders of tomorrow.

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National Electrical Week

THE 1961 National Electrical Week will be celebrated February 5 to 11. The all electrical industry event, which marks the birth of Thomas Alva Edison, is held each year during the week of February 11 to focus attention on the contributions of electricity. Strong support has been given to the event by major companies and corporations through radio, television, magazines, company publications and through special educational and promotional programs.

The National Electrical Week is sponsored by nine leading trade associations and professional societies and is endorsed by 15 others, including the American Society of Agricultural Engineers.

Evaporative Cooling for Animal Shelters in the North Central States

J. E. Mentzer and **A. C. Dale**
Member ASAE *Member ASAE*

THE research results reported in this paper were derived from a study of the effect of controlled temperature on the production of laying hens. However, a large part of the work pertains to the "pad and fan" evaporative cooling system and weather data which are not peculiar to any animal. Therefore, much of the material is applicable to any type evaporative cooling system in the midwest. Four phases of work were included in this study as follows: *(a)* laboratory pad test, *(b)* field pad test, *(c)* weather data analyses and *(c)* production of chickens in evaporative cooled pens.

Effect of Environmental Temperatures

Environmental temperatures directly affect the health and productivity of the laying hen and other animals by influencing their capacity to transfer heat from their body. At times of high environmental temperatures it is difficult for the laying hen to lose the normal amount of heat, and the hen may be subject to heat stress. Ota's (5)* work has shown that the laying hen produces eggs most efficiently when environmental temperatures are in the range of 55 to 60 F. As the temperature increases from the optimum range, egg production declines, but the rate of decline is rather gradual until approximately 80 F, and as the temperature increases above 80 F the rate of decline becomes much greater.

Not only is the number of eggs produced affected by high temperatures, but also the size of eggs and feed efficiency are affected. These factors are of prime importance to the commercial egg producer. Therefore, some thought was devoted to the possibilities of cooling laying hens during the hot summer months. Although mechanical refrigeration would provide adequate cooling, this method did not seem feasible; and the use of a simpler form of cooling seemed more reasonable, with the understanding that the optimum range could never be achieved. The reduction of extreme temperatures to moderate temperatures has some merit and was considered worthy of investigation.

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1959, on a program arranged by the Farm Structures Division. Authorized for publication as Journal Article No. 1685 of the Purdue University Agricultural Experiment Station.

The authors — J. E. Mentzer and A. C. Dale — are, respectively, extension agricultural engineer and professor of agricultural engineering, Purdue University, Lafayette, Ind.

Acknowledgments: The authors express appreciation to Norman D. Augsburger, Acme Equipment Co., for his assistance in furnishing supplies and equipment for the pad and fan system of evaporative cooling, and to Dr. Jack Long and the poultry science department for their cooperation and help.

*Numbers in parentheses refer to the appended references.

Evaporative Cooling

Evaporative cooling is a process of adiabatic saturation which involves the addition of moisture to the air without a transfer of external heat. The heat required to vaporize the water is supplied by the air, thereby decreasing the sensible heat of the air and also reducing the dry-bulb temperature. The addition of water vapor to the air increases the relative humidity, and, therefore, some consideration must be given to the effect of the higher humidity.

Effect of Humidity

The effects of relative humidity on the heat loss of laying hens has not been as thoroughly investigated as the effects of temperature; however, some of the work is of interest. Randall (6) indicated that, at high temperatures, high humidities reduced the hen's ability to dissipate heat. Yeates (8) states that relative humidities are unimportant at environmental temperatures of less than 85 F. Hutchinson (2) concluded that relative humidity hindered the natural evaporative cooling of fowls less than that of men; therefore, man's sensing devices are not accurate indicators of poultry comfort. If it may be assumed that the laying hen exhales air having a nearly constant heat content, the heat that may be expelled by respiration depends on the total heat content of the inhaled air. Based on this assumption, adiabatic cooling of the inhaled air would not affect the total amount of heat dissipated from the respiratory tract. However, the decrease in environmental temperatures can certainly improve the heat dissipation from the external surfaces of the laying hen by radiation, conduction, and convection.

High humidity can cause wet litter, dirty eggs, and unsanitary conditions which not only affect the hens but are undesirable to management (4). However, Deacon and Bozeman (1) stated that no moisture or litter problems were encountered with properly operated evaporative cooling systems.

Contrary to popular belief some preliminary study of weather data indicated that the midwest does not have higher wet-bulb temperatures than areas that have successfully used evaporative coolers. Since the wet-bulb temperature is the point to which the dry-bulb temperatures can be reduced, conditions can be attained equal to or better than can be achieved in what is considered dry climates (7) (Figs. 1 and 2).

Three types of evaporative coolers have been used in poultry houses: fogging, window type, and pad and fan. The pad and fan system appeared to be the most satisfactory type of evaporative cooling (1, 3). Therefore, for this study it was used.

Laboratory Tests of Pads for Evaporative Cooling

The evaporation of water from a moist pad is an adiabatic process. For a given set of conditions the amount of cooling can be calculated or taken from a psychrometric chart if the final degree of saturation is known. However, the saturation characteristics of moist aspen-shavings pads were unknown.

A simple laboratory test was therefore designed to determine the behavior of the pads. Because of the great variation among pads it would be difficult, if not impossible, to establish general saturation characteristics.

Aspen shavings were placed in a hardware cloth container two inches thick and one foot square forming a pad very similar to standard pads which were to be used in a poultry house. A fan was connected (Fig. 3) to the pad to form a laboratory test system in a climate control chamber. An orifice calibration curve for velocity was established with a hot wire anemometer. The pad was divided into 36 squares 2 in. on each side, and the velocity was read in

the center of each with the hot wire anemometer. These readings were averaged for an average pad velocity.

A climate control chamber controlled the dew point and dry bulb temperature of the entering air. The dry bulb temperature was held at a constant 90 F temperature, and the dew point was varied to achieve one of the four desired wet bulb temperatures and depressions: 5, 10, 15, and 22 F. The air was passed through the saturated pad at various velocities for each of the four wet bulb depressions. The velocity was determined by a calibrated orifice. Three readings of wet and dry bulb temperatures were taken to the nearest one-half degree by an aspirating psychrometer, as the air left the saturated pad. These readings were then averaged to arrive at the final wet bulb depression.

The results of this test are shown in Fig. 4. The deviation from wet bulb temperature shows that saturation was nearly complete. This may be subtracted from the initial wet bulb to show the amount of sensible cooling attained. The results confirm the ideas that a more nearly complete saturation is attained at lower air velocities and at lower initial wet bulb depressions. However, the greatest amount of cooling is attained when initial wet bulb depressions are large. The main value of the tests show in general how close the wet bulb temperature may be approached by evaporative cooling with a two-inch thick pad at velocities less than 175 fpm. In practically all cases the dry bulb was reduced to within 3 deg of the wet bulb. However, at the lower velocities the deviation of dry from wet bulb was less. These tests provide a basis for the correlation of the effectiveness of evaporative cooling with weather data.

Field Tests of Pads in a Poultry House

The pad and fan system was installed in one pen of a laying house having ten pens for environmental studies. The pen was 20 ft long, 9.5 ft wide, and had a volume of approximately 1500 cu ft. Two pads, each being 3 ft wide and 4 ft high, were installed with auxiliary equipment in a 4-ft by 6-ft opening in the south wall of the pen as shown in Fig. 5. The exhaust fan was located in the north wall. The pen was sealed except for the pads, requiring air to enter through the pads when air was being exhausted by the fan. The auxiliary equipment consisted of drip trough, a catch trough, a pump, and a recirculating pump. However, during part of the season water was taken from a supply directly to the drip trough and not recirculated. This induced a slight amount of sensible cooling. The exhaust fan was operated continually, but the pads were moistened for cooling from 7:00 a.m. to 7:00 p.m.

A hygrothermograph was placed permanently in the corner having the least circulation, and temporarily three other hygrothermographs were used in the pen. Periodically an aspirating psychrometer was used to check and adjust the hygrothermographs and to determine temperature distribution in the pen. Air velocities were measured with a hot wire anemometer. An air velocity reading was taken in each square foot behind the pad, and averaged to determine mean pad velocity. Although the variation of air velocity through the pads was considerable, because of nonuniform distribution of shavings, the average of the individual readings seemed to be the best indication of air

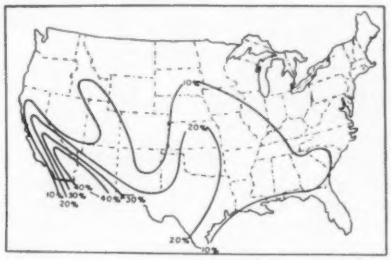


Fig. 1 Percent of hours above 90 F (dry bulb)

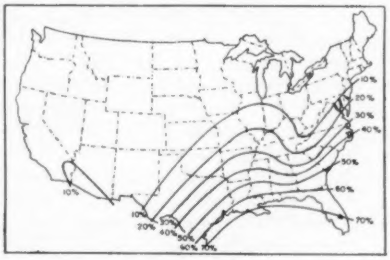


Fig. 2 Percent of hours above 74 F (wet bulb)

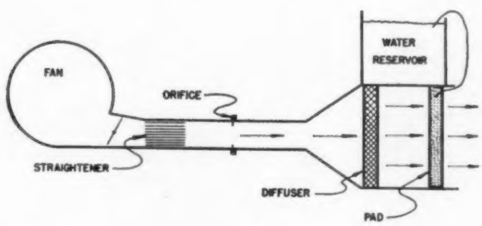


Fig. 3 Laboratory test equipment

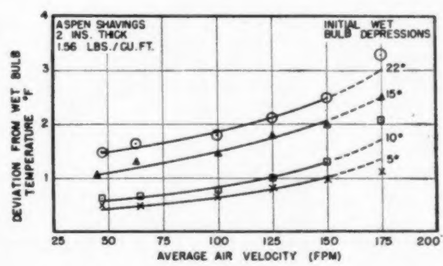


Fig. 4 Pad performance

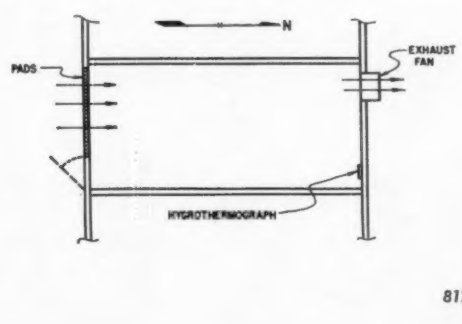


Fig. 5 Evaporative cooled pen

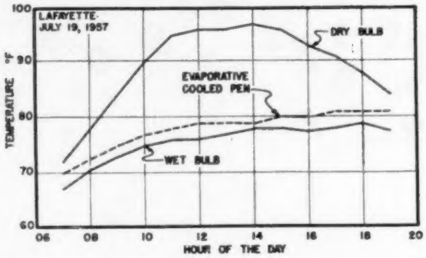
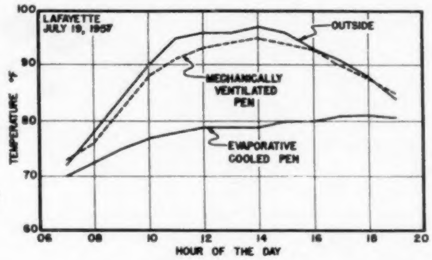


Fig. 6 *(Left)* Field performance

Fig. 7 *(Right)* Comparison of pens



movement. The mean air velocity through the pads was 70 fpm. Based on this velocity the rate of air flow was 1680 cu ft per minute or approximately one air change per minute. The air movement was fairly uniform throughout the pen.

Temperature distribution was reasonably uniform. However, the temperature of the air gradually increased as it passed through the pen. This increase was as much as 4 deg, but it was generally about 2 deg. These temperature rises cannot be contributed totally to heat load. Although the pen was sealed there was some infiltration of air that did not pass through the pads which would increase the air temperature.

The highest outside dry-bulb temperature, 97 F, during the summer occurred on July 19, 1957. Although this temperature was accompanied by a relatively high wet-bulb temperature, the dry-bulb temperature inside the pen was 18 F less. For this date, as shown by Fig. 6, the inside dry bulb varied from 1 to 4 F above the wet-bulb temperature. Fig. 7 compares the dry bulb temperature of the evaporative cooled pen, the outside, and a pen similar to the evaporative cooled pen having high mechanical ventilation occurring on the same date.

The maximum dry bulb temperature, 82 F, to occur in the evaporative cooled pen while the cooler was operating, did not occur on the day of maximum outside dry bulb temperature. The highest dry bulb temperature in the evaporative cooled pen was recorded on July 20, 1957. At the time of occurrence the outside dry bulb temperature was 94 F with a wet bulb temperature of 80 F.

All days were not as well suited for evaporative cooling as the previous examples, but considerable cooling was attained on a majority of days. The average, daily maximum, outside dry bulb temperature for July was 87.8 F, and the average, daily maximum, dry bulb temperature in the evaporative cooled pen for July was 77.1 F. This means that for July the maximum temperatures in the evaporative cooled pen were an average of 10.7 F less than the outside maximum temperatures. The dry bulb temperatures in the evaporative cooled pen were always within a few degrees of the wet bulb temperature which agrees with the results of the laboratory tests.

On extremely hot days the hens in the mechanically and naturally ventilated pens were observed to be panting, while the hens in the evaporative cooled pen were not panting. This is an indication that the laying hens in the evaporative cooled pen were more comfortable.

The litter absorbed some moisture from the humid air and was slightly damper than desirable. A small area of litter immediately behind the pads was much too wet. The water had a tendency to form droplets on the ends of shavings which extended from the pads, and the air passing through the pads carried the small droplets for a short distance into the pen.

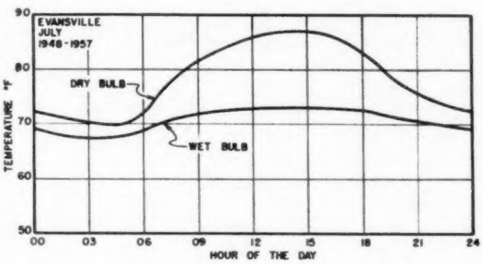
Dust in the incoming air collected in the moist pads. This tends to reduce air flow through the pads, but probably increased the saturation ability of the pads.

Because of the high ventilation rate, ammonia vapors were not objectionable in the evaporative cooled pen.

Collection and Analysis of Weather Data

Evaporative cooling is dependent on the conditions of the air, and it is necessary to determine the weather conditions that may be encountered to properly evaluate the possible effectiveness of evaporative cooling. The analysis of past weather conditions provides a basis

Fig. 8 Average hourly temperatures, Evansville, July, 1948-57



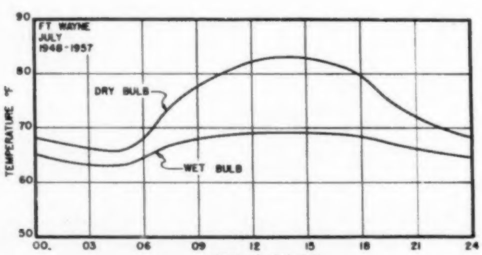


Fig. 9 Average hourly temperatures, Ft. Wayne, July, 1948-57

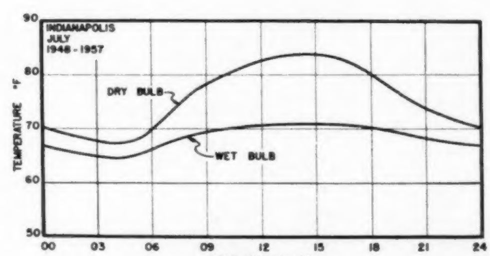


Fig. 10 Average hourly temperatures, Indianapolis, July, 1948-57

for the determination of expected conditions.

To make an analysis of weather in Indiana and to determine the possible effectiveness of evaporative cooling only two factors were considered: wet bulb temperatures and dry bulb temperatures. The dry bulb temperatures determine the need for cooling, and the wet bulb temperatures indicate the cooling that may be attained by evaporative cooling. These temperatures were obtained from hourly weather observations taken at three Indiana weather stations: Evansville, Fort Wayne, and Indianapolis. These observations were for June, July, and August, the months of highest temperatures, and were for a ten-year period, 1948-1957.

IBM cards having the desired data were obtained from the U.S. Weather Bureau. The data of one hourly weather observation were punched on one card. The cards were separated by station and month, and each of these divisions was subdivided by the hour. Then each final category contained the observations of one specific station, one specific month, and one specific hour for the entire ten-year period. The cards were then separated according to temperature into five-degree temperature increments. That is, a card having a temperature of 62 F would be placed in an increment of 60 F through 64 F. The number of cards or observations was then counted and recorded for each increment. This procedure was used once for dry bulb temperatures and once for wet bulb temperatures.

Assuming that the mean temperature for the five-degree increment was the mean temperature of all observations within the increment, the average hourly temperatures were computed. Figs. 8 through 10 are plots of these average temperatures.

For each station and month for a twelve-hour interval, 7:00 a.m. to 7:00 p.m., an accumulative distribution of observations was made. This twelve-hour interval contains the highest daily temperatures, and has more bearing on evaporative cooling than the cooler night temperatures. For the accumulative distribution the number of observations of the twelve-hour interval below the upper limit of each five-degree increment was determined. These values were then expressed in percent of the total observations in the twelve-hour period. Figs. 11 through 13 show part of these accumulative distribution curves. Table 1 and Table 2 list the factors of primary interest.

Discussion of Weather Analysis

There are no extreme variations in average temperatures across Indiana, but Evansville, representing the southern part of the state, has higher temperatures than Fort Wayne and Indianapolis. However, a comparison of the percent of hourly observations of dry bulb temperatures above 95 F shows that southern Indiana is subject to many more hours of extreme temperatures. Although the exact conditions at which heat stress losses justify cooling is unknown, the summer temperatures certainly have an undesirable effect on production. The departure of summer temperatures from the optimum indicates that losses due to heat stress might justify evaporative cooling.

The average wet bulb temperature is the lowest temperature that may be attained by evaporative cooling, and the average wet bulb depression is the number of degrees of cooling that may be attained. Figs. 8 through 10 show that

(Continued on page 821)

TABLE 1. MAXIMUM AVERAGE DRY BULB TEMPERATURES AND CORRESPONDING WET BULB TEMPERATURES

	Maximum average dry bulb temperature	Average wet bulb temperature at time of maximum dry bulb	Wet bulb depression
Evansville			
June	84.15	70.32	13.83
July	87.37	72.94	14.43
August	85.79	71.23	14.56
Fort Wayne			
June	79.65	66.17	13.48
July	83.52	69.18	14.34
August	81.58	67.21	14.37
Indianapolis			
June	80.85	67.92	12.93
July	84.03	70.72	13.31
August	82.71	68.68	14.03

TABLE 2. OCCURRENCE OF EXTREME DRY BULB TEMPERATURES 08-19 HOURS

	Percent of Observations above Dry Bulb Temperatures of			
	100F	95F	90F	85F
Evansville				
June	0.45	4.47	16.95	37.04
July	0.87	5.19	20.43	49.49
August	0.03	3.17	15.91	39.49
Fort Wayne				
June	0.03	0.81	6.66	19.97
July	0.08	1.53	9.[illegible]6	27.70
August	0.00	0.97	6.35	18.87
Indianapolis				
June	0.06	0.78	7.64	21.83
July	0.16	1.24	8.79	30.75
August	0.00	0.83	7.45	21.96

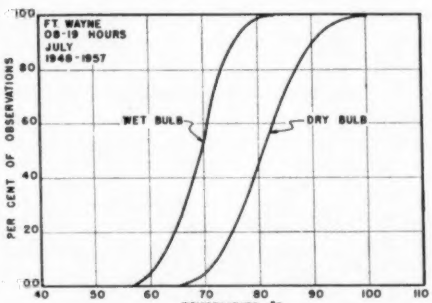


Fig. 11 Accumulated observation, Ft. Wayne, July, 1948-57

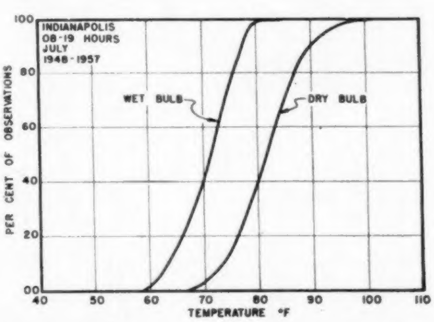


Fig. 12 Accumulated observation, Indianapolis, July, 1948-57

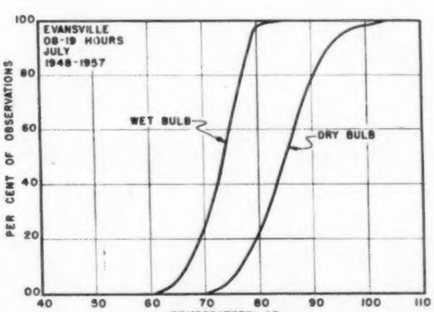


Fig. 13 Accumulated observation, Evansville, July, 1948-57

. . . Power Shift Transmission

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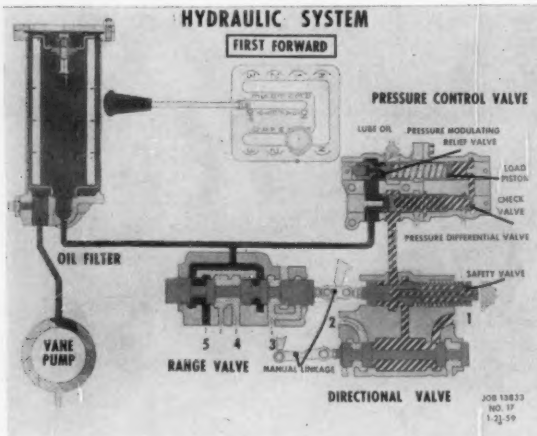

Fig. 7 The hydraulic-control system of the D8 transmission

The directional selector spool is a two-position spool which engages either the forward or reverse clutch depending on the transverse position of the control lever.

The dump spool which is connected to the speed selector spool is a four-position spool which drains the inlet port to the directional spool valve in neutral.

In the other three positions it connects the directional valve to the pressure-control valve. Attached to the end of the dump spool is a spring-loaded safety valve. Pressure in the directional clutch circuit ahead of the dump valve spool is directed into the area between the piston and the stem to compress the heavy spring. Whenever the oil pressure is down for an extended period of time, such as when the engine is shut off, the spring will force the oil out and move the piston forward to contact the transmission case. At this time spring load is sufficient to overcome the speed-selector spool detent and move the speed-selector spool and dump spool to their neutral position. This then assures that, when the tractor engine is started, the transmission control will be in neutral regardless of the last position the operator had selected. The small ball check in the safety-valve stem is used to retard valve operation to allow the operator to shift the control lever to position desired without any resistance from the safety valve spring during normal vehicle operation.

Up to this point we have been concerned with the manual operated portion of the hydraulic control system. The remaining portion of the controls are the pressure-control valves which regulate the pressure in the system and also provide proper sequencing of the clutches. This is accomplished by the use of a modulating relief valve, a differential valve and a check valve (Fig. 8).

The modulating relief valve, consisting of the relief valve, spring and load piston, is used to regulate the system pump pressure. The differential valve is used to sequence the engagement of the speed clutches prior to engaging the directional clutches. The check valve is used to control the rate of pressure rise in the system and also to reset the modulating relief valve during each shift.

The pump pressure during a speed shift drops to fill pressure (pressure required to force pump flow through the speed selector into the speed clutch). Upon completion of clutch fill, the pressure rises sufficiently to move the differential valve, shutting off the directional clutch drain and allowing flow into the directional clutch circuit through the orifices. The resulting fill pressure will unbalance the forces acting on the floating check valve and move it toward its stop, thus closing off the load piston drain. Since all pump flow cannot pass through the two orifices in the differential valve, the pump pressure will continue to rise until the relief valve will open and by-pass the excess flow. Upon completion of the directional clutch fill, the directional clutch pressure will rise from fill pressure to 55 psi less than initial relief-valve regulating pressure. This increase in pressure through the check valve to the load piston will unbalance the forces acting on the load piston — force of directional clutch pressure acting on load piston area exceeds force exerted in opposite direction by pump pressure acting on relief valve slug area — and cause movement of the load piston to compress the relief valve spring which in turn causes a rise in pump pressure and directional clutch pressure. The rate of movement of the load piston is determined by the size of the orifice in the check valve, all other things remaining constant. When the load piston has traveled far enough to contact the stop, the pump pressure has risen to 300 psi. During this modulating (pressure rise) cycle, the differential valve has maintained a 55 psi differential between pump pressure and directional clutch pressure.

When another speed range is selected, the pump pressure will again drop to fill pressure at which time the differential valve will shift, opening the directional clutches to drain. This drop in pressure in the directional clutch circuit causes another unbalance on the check valve letting it shift toward the differential valve and open the load piston passage to drain. This then allows the load piston to move, thus reducing the spring load exerted on the relief valve. The control is now ready for completion of the modulation cycle by filling the speed clutches, filling the directional clutches and then modulating the system pressure from about 90 to 300 psi.

The resultant modulation (controlled rate of pressure rise) obtained by the use of this control provides a smooth

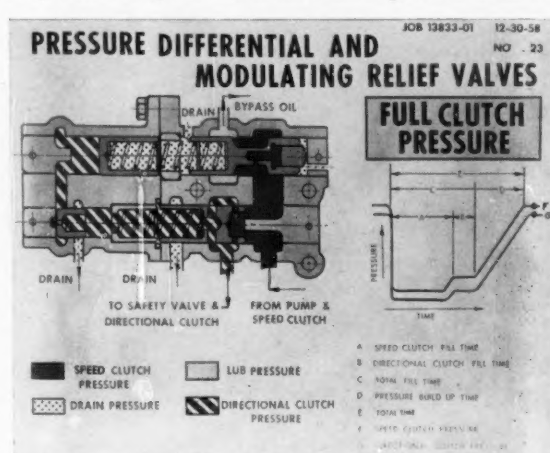

Fig. 8 The pressure-control valves which regulate pressure in the system and provide proper sequencing of the clutches

clutch engagement and reduces the severity of the torque peaks imposed on the power train from the transmission to the track sprocket.

The combined effects of this transmission arrangement including the torque converter with its planetary gearing, the three-speed forward and reverse planetary transmission with its hydraulic control, provides a track-type tractor which can be deftly controlled by one man. The transmission provides the following advantages in a given size machine: More production, better maneuverability, less operator skill required, more adaptability to load, faster shifting, less tiring for the operator, and greater safety.

Our field experience indicates that these advantages are recognized and utilized in the field. The over-all performance of the machine is no longer excessively dependent upon operator skill, but the power-shift transmission allows the average operator to approach the performance of the most skillful and for both to better his performance.

. . . Evaporative Cooling

(Continued from page 819)

after the sun rises the wet bulb temperature gradually increases, but that the dry bulb temperature increases much faster. Although this increases the lower limit of evaporative cooling, the wet bulb depression increases. This permits more degrees of cooling at the time of the maximum dry bulb temperature than at other times of the day. For a specific time of the day the average wet bulb depression is nearly the same for all three summer months and for all three stations. The average wet bulb depressions of all months and stations at the time of the maximum dry bulb temperature were in the range of from 12.93 to 14.56 F. The average wet bulb temperatures signify that dry bulb temperatures can be reduced by evaporative cooling and create more satisfactory environmental temperatures for laying hens.

The maximum wet bulb temperature observed during this ten-year period was 83 F. This maximum and the relatively few wet bulb temperatures exceeding 80 F clearly indicates that high humidities do not accompany high dry bulb temperatures. By the use of a psychrometric chart, the wet bulb temperatures exceeding 80 F and the corresponding dry bulb temperatures, it was determined that the highest relative humidity for a dry bulb temperature of 90 F was 70 percent, for a dry bulb temperature of 95 F it was 58 percent, and for a dry bulb temperature of 100 F it was 48 percent.

Yeates (8) stated that at dry bulb temperatures of less than 85 F, relative humidities are relatively unimportant. Since evaporative cooling will always maintain dry bulb temperatures under 85 F in Indiana, the adverse effects of high humidity on laying hens being evaporative cooled should be slight.

Production of Laying Hens

During the summer of 1957 insufficient records were taken to evaluate production. In 1958 and 1959 somewhat better records were obtained. However, because the laying hens are normally sold by the poultry department in August, one month of the summer was lost.

The evaporative cooled pen was divided into three pens and 16 White Leghorn hens were placed in each. These hens were randomly selected and placed in the pens at the same time the other pens in the environmental house were filled. This was in September, and the pen was subject to conventional ventilation and management until the following summer. When the temperatures began to rise the pad and fan system was started and thermostatically controlled to operate at temperatures above 70 F.

The poultry department kept records of egg production, egg size and feed consumption. The time a group of hens was kept was broken into 28-day periods and usually the hens were kept for eleven full periods and one partial period.

Complete records were kept during the period of September 1958 to August 1959. The hens in the evaporative-cooled pen were numerically but not significantly lower in production until the arrival of hot weather and the use of evaporative cooling. At this time the production of the evaporative cooled hens surpassed that of the normally ventilated check pens, but this difference was not statistically significant. There were no significant trends or differences in feed efficiency or size of eggs.

The most accurate complete records were kept during the period of September 1958 to August 1959. The hens in the evaporative-cooled pen were numerically but not significantly lower in production until the arrival of hot weather and the use of evaporative cooling. At this time the production of the evaporative cooled hens surpassed that of the normally ventilated check pens, but this difference was not statistically significant. There were no significant trends or differences in feed efficiency of size of eggs.

Summary

The pad and fan system can be a very effective form of an evaporative cooler, reducing dry bulb temperature to within a few degrees of wet bulb temperatures.

Evaporative cooling is more suitable to the midwest than has normally been believed. Although an optimum environment can not be attained by this means, observations indicate that environmental temperatures may be improved, but this can not be significantly indicated by production.

Wet bulb temperatures were always 83 F or less indicating that dry bulb temperatures can be reduced to 85 F or less by evaporative cooling. Below this temperature, humidity is not an important factor. Therefore, it can be assumed that, during a time of extremely high dry bulb temperatures, some relief can always be attained by evaporative cooling.

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Tile Flow Measured Electrically

R. H. Hahn and G. O. Schwab
Assoc. Member ASAE   Member ASAE

A three-dimensional electric analog model was developed for determining tile flow through a two-layered soil

ELECTRIC analog models are adaptable for solving problems involving the flow of fluids through porous media. The model approach is suitable for verifying theoretical equations and for solving problems with complicated boundary conditions which are difficult to evaluate mathematically. Two-dimensional models (9, 5)* have been constructed to evaluate flow through porous media of varying permeability, and three-dimensional models (2, 8) have been developed for completely homogeneous media.

For this study a three-dimensional electric analog with two layers of conductors with different permeability was developed. A model was then developed to determine the effect of depth and spacing of tile drains on flow through a two-layered soil.

Theory

The model theory is based on the analogy between Darcy's law governing the flow of water through saturated soil and Ohm's law governing the flow of electric current through a conductor. In comparing the two laws, the quantity of water flow corresponds to electric current flow, hydraulic gradient to voltage gradient, and soil hydraulic conductivity to specific electrical conductivity (7). Boundaries in the soil that are impermeable correspond to insulated parts of the model, and surfaces of equal hydraulic head correspond to conductors at constant electrical potential.

In the application of this electric analog model to tile drainage problems various assumptions and conditions must be kept in mind, namely:

(a) The model represents saturated soil conditions.

(b) An impermeable layer exists at a finite depth.

(c) The conducting surface of the drain represents the openings in the drain. (In this study the drain was completely open.)

(d) No water is removed from the soil except through the drain (no deep seepage).

(e) The permeability of each soil layer is isotropic.

(f) The drain is flowing full with no back pressure, that is, the drain is an equipotential surface.

Equipment and Materials

The tile drainage model and electrical equipment are shown in Fig. 1. The sides and ends of the tank model were made with lucite, a nonconductor. The scale of the model was 4 to 1. Because of symmetry, the tank and drain were made one-half models. The 4-in. draintile was represented by a chrome plated half-cylinder shown at the right end of the tank in Fig. 1. The soil surface was represented by a copper sheet in the bottom of the tank.

The resistance of the model was measured by balancing the Wheatstone bridge circuit shown in Fig. 2. The instruments shown in Fig. 1 are (A) Superior Electric Co. powerstat variable autotransformer, *(B)* Weston a-c voltmeter, *(C)* two Heath decade resistors, 10,000 ohms, *(D)* Ballan-

Paper presented at the Annual Meeting of the American Society of Agricultural Engineers at Columbus, Ohio, June 1960, on a program arranged by the Electric Power and Processing Division. Approved for publication as Journal Paper No. 56-60 of the Ohio Agricultural Experiment Station.

The authors — R. H. HAHN and G. O. SCHWAB — are, respectively, project engineer, O. M. Scott and Sons Co., Marysville, Ohio (formerly graduate student, Ohio State University, Columbus), and professor of agricultural engineering, Ohio Agricultural Experiment Station, Columbus.

*Numbers in parentheses refer to the appended references.

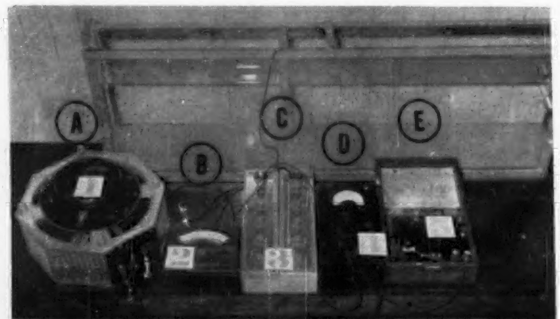

Fig. 1 Tank model and electrical equipment. (A) transformer, (B) voltmeter, (C) resistances R_1 and R_2, (D) electronic voltmeter, (E) variable resistance, R_3

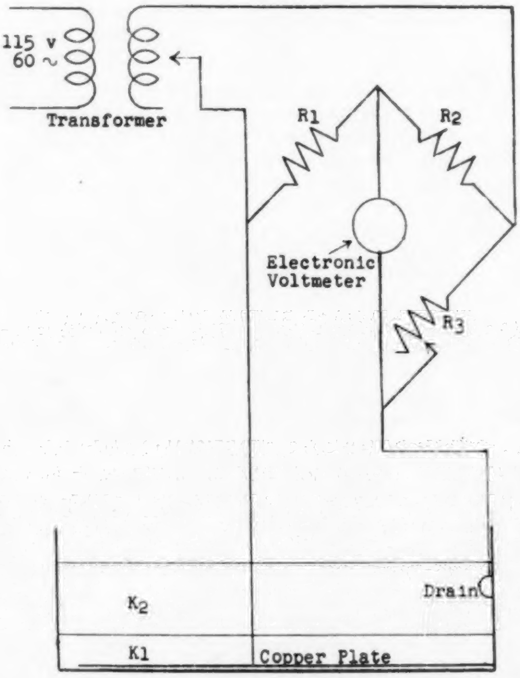

Fig. 2 Circuit diagram and model

tine model 300 electronic voltmeter, and *(E)* Industrial Instruments Co. model RN-2 variable resistor.

To represent two soil layers of different permeability in the model, it was necessary to find two conducting liquids, or electrolytes, that were immiscible with each other. Considerable difficulty was encountered. A list was compiled of 633 organic compounds liquid at room temperature and immiscible with water. However, none of the listed organic compounds were conductors. Bernthsen and Sudborough (1) reported that certain alcohol and water mixtures could be "salted out" or separated by the addition of calcium chloride. This possibility proved to be the necessary clue for solving the problem. By adding isopropanol (isopropyl alcohol, $CH_3.CH(OH).CH_3$ to a saturated solution of calcium chloride and water, two distinct layers were formed. Since the layers remained immiscible and each possessed a different electrical conductivity, they were acceptable as media in the analog model. Isopropanol which was 99 percent carbide and carbon and a 77 to 80 percent pure commercial grade of calcium chloride were the chemicals.

The ratio of the electrical conductivities between the two electrolytes was 21 to 1. Thus, the model represented a drainage condition in which the permeability of the topsoil layer (lower electrolyte of water and calcium chloride in the model) was 21 times the permeability of the subsoil layer (upper electrolyte of isopropanol in the model).

Application of the Analog

A series of tests was run to determine the effect of drain depth and spacing on the relative flow to a 4-in. open drain through a two-layered soil. The results are shown in Fig. 3 for a spacing of 12 ft. For these same conditions the spacing was increased to 30 ft, but the increase in flow was less than 4 percent. Kirkham (4) developed a theoretical equation for a two-layered soil, but it could not be compared directly to the analog results because the impermeable layer was at infinite depth, a condition impossible to obtain in the model. However, the theoretical results and the analog data showed that the minimum flow for such two-layered soil occurred at depths from 1 to 2 ft. As the depth to the impermeable layer decreased, the flow likewise decreased at drain depths greater than 1 ft. The flow must decrease to zero where the tile were embedded completely in the impermeable layer.

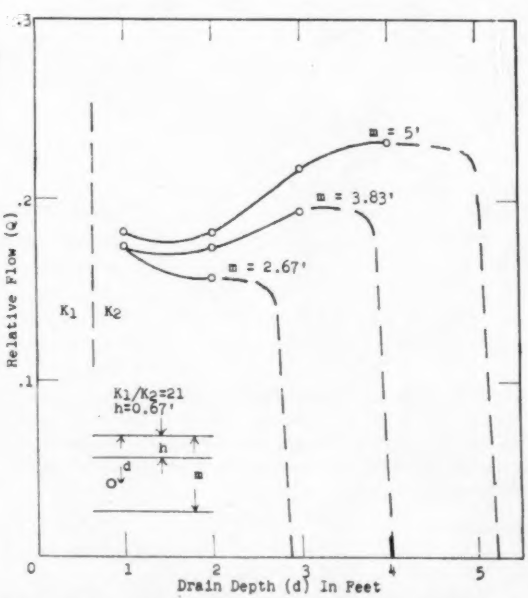

Fig. 3 Effect of draintile depth on inflow for a spacing of 12 ft

By changing the tile model electrode from a completely open drain (entire cylindrical surface a conductor) to an electrode representing a crack between adjacent tile or perforations in the drain, the three-dimensional analog could be demonstrated. This application of the model was not made because the effect of depth was of primary interest at the time.

By moving the copper sheet (soil surface) from the bottom of the tank to near the surface of the electrolyte, a soil with a slowly permeable layer above and a more permeable layer below could be represented. This three-dimensional analog would be applicable to a horizontal or a vertical drain in a two-layered soil. The vertical drain is essentially a well, and it could be perforated in any configuration. Determination of the geometry factor or verification of theoretical formulas for measuring hydraulic conductivity with vertical wells is another application of the analog.

Discussion

The analog was developed only for two soil layers of different permeability, and the ratio of permeability of the two layers was constant. Further investigation is needed to secure more flexibility in order to more nearly represent actual soil conditions. For two-dimensional flow problems the electrical resistance network described by Luthin (5) appears to be simpler and more flexible than a liquid analog model. However, where the effects of perforations and well flow problems exist the three-dimensional analog is required. The results shown were included primarily to demonstrate that the two liquids would not mix, and that the model is valid.

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INSTRUMENT NEWS

Plastic Drain Liners Evaluated by Pneumatic Test Chamber

Development of various forms and thicknesses of plastic mole-drain liners to deformation by soil pressures.

P. L. Manley
Assoc. Member ASAE

DEVELOPMENT of various forms and thicknesses of plastic mole-drain liners, has stimulated researchers to devise a means for evaluating relative resistance of different liners to deformation by soil pressures.

A mole-drain liner placed in soil is subjected to an active pressure from the weight of overlying soil and from loads applied at ground surface. Soil also provides passive resistance against outward movement of the liner. Most plastic liners now used are quite flexible, therefore support for the liner from passive resistance in the soil is more fully utilized than by more rigid conduits such as clay tile.

Standardized tests for evaluating relative strengths of rigid conduits such as clay and concrete tile do not apply as well to a flexible plastic drain liner because of differences in physical properties. Attempts to evaluate plastic drain liners with standardized tests for tile, or by applying loads over drains installed in a soil, have met with little success. The method of surface loading would seem to be the most logical approach, however, variation of soil properties make replicated tests by this method time consuming and difficult.

A pneumatic testing chamber (Fig. 1) was developed to evaluate the resistance of various flexible liners to deformation under pressure similar to those exerted by a soil. In construction the upper portion was removed from a section of pipe (D) and a 3-in. diameter gummed rubber tube (C) was slipped over the pipe and clamped at both ends. A perforated sheet metal pipe (B) was placed tightly around the rubber tubing to support the tube against movement outward (passive resistance). This assembly was then placed inside an airtight chamber (A) with both ends of the smaller pipe exposed for inserting different liners.

Active soil pressures were simulated by varying pressures within the chamber. The relative strength of different liners was found by measuring the pressure required to cause the liners to collapse.

The device was designed primarily for the testing of arch-type plastic liners formed from a plastic strip 6 in. wide (1)*, and for full-circle plastic liners (2). Testing was limited to 3-in. diameter drains. Simulated active pressures in excess of 40 psi caused the rubber tubing to burst. With modifications in design, however, this principle of testing could be used for evaluating most types of flexible underground conduits.

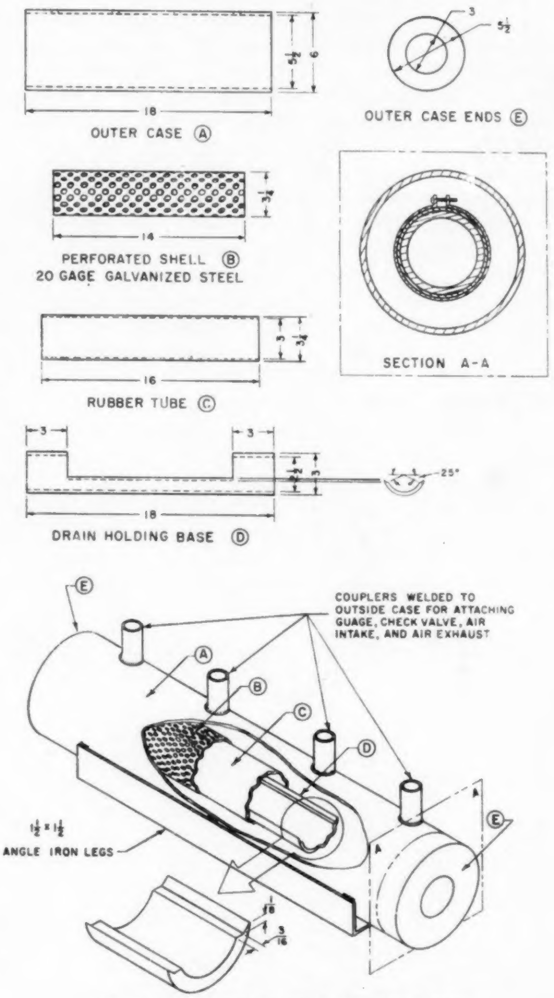

Fig. 1. Test chamber for flexible drain lines

An Instrument News Contribution from the Soil and Water Conservation Research Division, ARS, USDA, in cooperation with the Cornell University Agricultural Experiment Station, Ithaca, N. Y. Articles on agricultural applications of instruments and controls and related problems are invited by the ASAE Committee on Instrumentation and Controls, and should be submitted direct to Karl H. Norris, instrument news editor, 105A South Wing, Administration Bldg., Plant Industry Station, Beltsville, Md.

The author P. L. MANLEY — is agricultural engineer, ARS, USDA, Ithaca, N. Y.

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. . . Fluorocarbon Resins

(Continued from page 803)

stacle to the removal of heat, and requires design consideration.

The primary factors in heat generation are usually expressed in terms of the PV factor; this equals the product of the load (in pounds per square inch) of projected bearing area and the surface speed (in feet per minute). With Teflon resins, PV values are used only as guides because of the change in coefficient of friction with speed and load noted earlier in this paper. However, for a guide it is valuable. It is also beneficial to determine a maximum surface speed and a maximum load for each bearing composition to further control the very flexible PV value.

Most bearings of fluorocarbon resins take advantage of the tremendous improvements in properties offered by filled compositions. The improved wear resistance, thermal conductivity and load-bearing properties of filled compositions can be vividly illustrated by comparing PV values. Bearings of unfilled TFE resins reportedly wear rapidly in unlubricated service at PV values above 1,000. Filled compositions have been reported to run unlubricated at PV values up to 15,000 with wear rates less than 0.1 mil per hour (3). Many processors have developed their own filled compositions and these have exhibited excellent bearing performance when used as recommended.

Startling improvements in the performance of bearings of TFE resins have been achieved by making the resin sleeve as thin as practical to facilitate heat removal. The use of a thin sleeve also reduces cost, thermal expansion effects and creep.

"Floating" bushing inserts of tape made from filled TFE resins are giving very good performance in many applications, and are simple to install. These bushings are retained in a groove or sleeve, and a diagonal gap in the tape is provided to permit circumferential thermal expansion and smooth rotation.

Metal backing or encapsulated metal reinforcing can be used to retain bearing dimensions and to dissipate heat. PV values of 20,000 (unlubricated) are reported for bearings of filled TFE resin with metal backing (3).

Since 1957, highly oriented fiber of Teflon has been offered commercially by the textile fibers department of the Du Pont Company. As a bearing material, fabrics of Teflon TFE-fluorocarbon fiber have been successfully used in high-load, low-speed applications such as spherical and ball-and-socket bearings in automotive suspension and steering-linkage systems, as well as for flat bearings and journal bearings. In applications where very slow oscillating or sliding speeds are involved, bearings made from these fibers have been successfully used without lubrication at loads up to 60,000 psi.

Summing up the use of TFE bearings, all bearings that are giving trouble cannot be replaced with Teflon resins . . . there are jobs that they definitely cannot handle. Be conservative with the parameters of speed and load, work with a reliable processor, and evaluate the prototype bearing under expected operating conditions.

Automatic Seals

Almost complete chemical inertness and the wide useful temperature range of TFE resins led to their early use as packing and gasket materials. Taking advantage of the resins' exceptional frictional properties, seals of these resins were a natural progression.

The variety of seals now available appears limitless because of modifications in basic seal design originated by individual fabricators. At the present time, TFE resins are successfully employed in lubricated and non-lubricated piston rings, mechanical end-face seals, O rings and lip seals, including cup seals, rod seals, U seals and V-ring seals.

Lip seals appear to have the greatest possibilities for seal application to farm equipment. As was the case in bearing applications, heat generation in a seal is the problem to be licked. Here the 500 F continuous operating temperature of TFE resins is higher than temperatures recommended for many shaft materials. And fluorocarbon resins will not harden with heat. Lip seals are recommended by various suppliers for rotary surface speeds up to 200 fpm in unlubricated service, and substantially higher for reciprocating motion or for lubricated service. Evaluation of rotary seals of Teflon resins under actual conditions may result in successful unlubricated applications at speeds up to 600 fpm.

For lip seals subject to wide variations in temperature, spring expanders are helpful as a means for overcoming the seal's tendency to contract and lose sealing ability with cooling.

In cup and rod seals, advantage is taken of the fact that deformed parts of Teflon resins tend to return to their original shape when heated. A seal can be formed from a flat sheet in such a way that the stresses created will cause it to seal more tightly with rise of temperature. Seals of this variety have been used successfully at 450 F (4).

Wiper rings should also be mentioned. Keeping dirt, dust and foreign matter from adhering to a rod and being drawn into the equipment is no problem for rings or cups of Teflon resins. The ability of the resin to safely embed solid particles further enhances its ability in this application.

Suppliers of seals can provide detailed dimensional information about their packings and seals. As in the case of bearings, their advice can be invaluable.

Anti-Stick Properties

Closely allied to the amazing low-friction properties of fluorocarbon resins are their release and anti-stick properties. Because of the very weak attraction between fluorocarbons and other molecules, nothing sticks with any strength to their slick surface. Alert designers are finding new ways each day to use these anti-adhesive properties.

Many forms of Teflon resins are now available for application to various substrates as means of providing anti-frictional, anti-stick surfaces. Sheet and tape of filled or unfilled resins come in various thicknesses and sizes. They can be obtained already bonded to a substrate or with an adhesive on one side, or with a specially treated surface for application via conventional adhesives.

Glass fabric having a coating of TFE resin applied to only one side to permit bonding to the glass is available. Metal encapsulated in sheeting of Teflon resins permits mechanical fastening.

The fabrics and finishes department of the Du Pont Company markets an enamel of Teflon resin that can be baked on. Objects can be coated with 100 FEP resin by the fluidized-bed technique; or film of FEP resin can be

. . . Fluorocarbon Resins

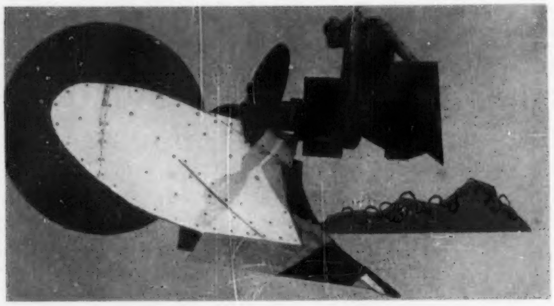

Fig. 3 The moldboard of the plow shown is covered with a sheet of Teflon TFE resin, which permits easier, more efficient plowing of colloidal soils, since they will not adhere to the moldboard. Also plowing time and power required are greatly reduced

heat-bonded to substrates of steel, copper, aluminum, glass and TFE resins. Now commercially available, other liquid resin systems incorporating Teflon dispersion permit laydown of 1 to 2-mil thick films of TFE on irregular surfaces and heat-sensitive materials such as wood, rubber, paper, etc.

In most cases, the abrasion resistance required by the application is the prime factor in determining the resin form to use.

Typical farm applications of Teflon resins include the coating of plow faces for improved efficiency in the colloidal soils of Hawaii (Fig. 3), trough linings, conveyor chutes and belts for handling sticky silage or locations where dirt and plant juices accumulate, paint spray hose, barn cleaners, feed hoppers, and storage bins. The fact that ice does not stick to Teflon resins can assist in eliminating cold-weather freeze up of parts on equipment that must operate in all weather conditions.

In new designs and through conversion of existing equipment, components of Teflon offer such advantages as easier operation, longer life, simpler cleaning and reduced maintenance and downtime.

If a release or anti-stick problem exists, there is now a method for applying Teflon resins to almost any substrate to help solve the problem.

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RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural-engineering interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

Pettibone with AERD

C. Allan Pettibone, a recent graduate of Washington State University, has joined the Farm Electrification Research Branch of AERD, ARS, USDA.

Stationed at Pullman, Wash., he will conduct studies on the effects of electric glow discharge radiation on plants and plant products of particular interest in the Northwest.

Mr. Pettibone has a reserve commission in the U. S. Army Corps of Engineers and was on active duty 2 years. He is married and has one son.

Appropriations for Poultry Labs

Funds for two new poultry disease laboratories have been approved by Congress. Both laboratories are scheduled to open in 1961.

A $950,000 building will be built at Athens, Ga., and a $400,000 structure at State College, Miss. Particular attention will be given to the relationship of housing to diseases in studies at the State College laboratory. It is expected that agricultural engineers of AERD, ARS, USDA will have major responsibility for work there and will be well represented in the Georgia laboratory.

Publication Reprints Available

Reprints of three research reports—on cotton quality preservation and control at gins, reducing fruit harvest labor costs, and response of soybeans to seed treatment with gibberellin—are available.

Authors of the report on cotton are agricultural engineers Joseph B. Cocke and James A. Luscombe of AERD, ARS, USDA. They discuss the effects of ginning techniques on quality and make several recommendations for improving ginning systems.

The report on fruit harvesting, by AERD agricultural engineer S. W. McBirney, explains efforts underway at Wenatchee, Wash., to develop more efficient and profitable methods through use of mechanized equipment.

In discussing results of field studies at different locations, several USDA, State, and Canadian agricultural engineers and scientists report that use of gibberellin on soybeans is not yet advisable. However, the possibility remains that useful formulations or techniques might be developed.

The reprints will be sent by the Harvesting and Farm Processing Research Branch, AERD, ARS, Room 326, North Building, USDA Plant Industry Station, Beltsville, Md. Mention "Cotton Quality Preservation and Control at Gins," "Reducing Costs of Harvest Labor," and "Response of Soybeans to Seed-Treatment with Gibberellin Under Simulated Commercial Conditions."

ARS Releases New Report on Corn Topping

A second report on the effect of corn topping has been released by ARS and the Iowa Agricultural Experiment Station. A follow-up to "Report on Effects of Corn Topping" of August 1959, the new publication, "Corn Topping – Its Effect on Field Drying and Harvesting," notes that there is little value in topping corn beyond increasing comfort and visibility for picking machine operators.

Farm Building and Equipment Plans Released

A number of plans for farm buildings and facilities were released by the Cooperative Farm Building Exchange last month. They include: 12 single sheet plans for such structures as loose dairy housing layout, a milking plant layout, a milk house, calf and maternity buildings and a stall type dairy barn; two 3-sheet farm home plans for 2-bedroom farmhouses; and plans for sheep production equipment, a mineral feeder, an electric brooder for pigs, a self-feeding hay wagon and a hay and grain feeder for sheep.

USDA Engineers Assume New Posts

J. L. Butler and R. E. Hellwig moved to the Coastal Plain Experiment Station, Tifton, Ga., to initiate research on the pelleting of Coastal Bermuda grass and other forage crops grown in that area. Dr. Butler was formerly with the Georgia Agricultural Experiment Station at Griffin, and Mr. Hellwig transferred from the Long Vegetable Fiber Crops Engineering Research Station at Belle Glade, Fla.

J. M. Williams joined the staff at the Southeastern Cotton Ginning Laboratory, Clemson, S. C., on August 1. He transferred from Southwestern Cotton Ginning Laboratory at Mesilla Park, N. Mex.

Thomas E. Kent will transfer from the Agricultural Research Center, Beltsville, Md., to Blacksburg, Va., where he will cooperate with the Virginia Agricultural Experiment Station in research aimed at defining the loads imposed on farm structures, explaining how the elements of the completed structure interact with standard reactive forces created by loads, and evaluating the practicability of new materials or conventional materials used in new ways.


Jack-of-
all-work

Oliver New Subsidiary of White

On October 31 stockholders of both The White Motor Co. and The Oliver Corp. approved the acquisition by The White Motor Co. of Oliver's farm equipment business and a two-year option to purchase Oliver's industrial equipment and crawler tractor business. It also obtained sales and service for Oliver's industrial equipment and crawler tractors.

The farm and industrial equipment business will be operated as a wholly-owned subsidiary of The White Motor Co. and will be known as Oliver Corp. The Oliver name will be retained on all Oliver products. Until such time as the two-year option is exercised, industrial equipment and crawler tractors will continue to be manufactured by the previous Oliver Corp., which has taken the name, Cletrac Corp.

Samuel W. White, Jr., 15 years with The Oliver Corp. and not related to the White family which founded White Motor, has been elected president of the new subsidiary. Other new officers are: B. Haugen, vice-president of finance; D. W. Koegle, vice-president of marketing; L. P. Richie, vice-president of manufacturing; T. W. Kavanagh, treasurer; S. A. Baker, controller; D. W. Alfvin, secretary; C. E. Swingley, assistant treasurer; G. R. Lanphere, assistant treasurer and assistant secretary; J. W. Dwyer, assistant controller; E. N. Culp, president of Oliver International, S. A.; L. A. Dyke (ASAE member), vice-president headquartered in Australia; and H. W. DeMent, vice-president and general sales manager.

GPMMA Plans Expanded Activities Program

Officers of the Grain Processing Machinery Manufacturers Assn. met recently in Kansas City to discuss expanded association activities. Included in this program is a plan for closer cooperation with colleges and universities with emphasis on research. Added services to members in the form of news and technical information releases, and a new "products chart" listing member companies and their products are also integrated in this over-all program. Plans for the 1961 National Feed Industry Show and the GPMMA annual meeting were also discussed.

Grain Processing Machinery Manufacturers Association President C. N. Hultberg *(right)* and the newly appointed secretary, John H. Wessman, discuss plans for the association's expanded activities and services during recent Feed Production School held in Kansas City, Mo.

ASEE Awards

Each year the ASEE makes a number of awards to outstanding engineers. The following awards will be made in 1961: George Westinghouse Award in Engineering Education — $1,000 for distinguished contribution to the teaching of engineering students; Curtis W. McGraw Research Award —annual award to honor a young staff member for contributions to engineering college research; Vincent Bendix Award for Engineering Research — an annual presentation of a gold medal and bronze replica for outstanding contributions to engineering college research; and Lamme Award in Engineering Education — an annual award bestowed upon an engineering educator for distinguished achievements which contribute to the advancement of the profession. Nominations for these awards are requested by January 1, 1961. Details and application blanks for these awards may be obtained from W. L. Collins, secretary, ASEE, University of Illinois, Urbana, Ill., or A. W. Farrall, chairman, ASAE Division of ASEE, agricultural engineering department Michigan State University, East Lansing, Mich.

Death Takes Farm Equipment Inventor

Harry Ferguson, farm equipment inventor, passed away in London, October 25, at the age of 75.

Mr. Ferguson will be remembered in ASAE, particularly, as the donor of the Ferguson Fund for advancement of agricultural engineering education. The fund was used initially to finance publication of a series of professional-level texts in agricultural engineering.

After the text financing was completed, a balance of several thousand dollars was turned over to ASAE to finance teaching seminars and otherwise advance training in this field. The fund paid a part of the cost of several teaching seminars in the period between 1946 and 1960. By direction of the Council the final balance in this fund was transferred to the Motion Picture Fund during the current year, to help finance supporting literature in the interest of making accurate information on agricultural engineering training widely available to qualified students.

Committee Meets at ASAE Headquarters

The ASAE Finance Committee met at the Society headquarters in St. Joseph, Mich., on November 18, with the following members in attendance: Earl D. Anderson, director of agricultural extension, Stran-Steel Corp.; Lee H. Ford, supervisor, engineering product publications, International Harvester Co.; F. A. Lyman, account executive, Aubrey, Finlay, Marley & Hodgson, Inc., and Nolan Mitchell, director of sales, Aerovent Fan and Equipment, Inc.

L. H. Hodges, director of engineering, J. I. Case Co., and chairman of the ASAE Power and Machinery Division Technical Committee also visited the Society headquarters on November 10 to organize the agenda for the committee meeting to be held in conjunction with the ASAE Winter Meeting.

EJC Elects New Officers

James N. Landis, vice president of the Bechtel Corp., recently has been elected president of Engineers Joint Council. He succeeds Augustus B. Kinzel, vice president of Union Carbide Corp. Re-elected as vice-president was George E. Holbrook, vice-president, E. I. du Pont de Nemours & Co.

Water Management Conference

The Ohio Water Commission held a Water Management Conference on December 8 and 9 at the Youth Center, State Fairgrounds, Columbus. The purpose of the conference was to hear reports on the status of existing agency programs; to present recommendations on new water policies; and to discuss proposed legislation to implement these policies. The following ASAE members participated in the agriculture session: John A. Slipher, Lloyd L. Harrold, Melville L. Palmer, and Charles L. Hahn.

1961 Kiln-Drying Short Course

The 1961 Kiln-Drying Short Course will be held from February 27 to March 3 at Purdue University, Lafayette, Ind. This five-day course in kiln-drying and seasoning of wood will combine the resources of a number of educational institutions and industrial firms. Major emphasis will be placed on the practical aspects of seasoning, and anyone engaged in drying lumber or in handling and manufacturing wood products will find this short course of instruction, demonstration, and discussion helpful.

1961 National Dairy Engineering Conference

The Ninth Annual National Dairy Engineering Conference will be held at Michigan State University on February 28 and March 1. The conference will be devoted to automation of dairy plant operations and will include speakers from processing plants, equipment manufacturers and others interested in the subject of automation. The Conference is sponsored by the department of agricultural engineering in cooperation with the department of food science and the National Association of Dairy Equipment Manufacturers.

FHA Has New Soil Testing Device

The Architectural Standards Division of the Federal Housing Administration has announced that a simple field device for testing the behavior of soils involving residential foundations, driveways, utility installations, etc., has been developed. This engineering short cut to evaluating potentially dangerous conditions existing in some clay soils used in residential developments has been designated as "FHA Soil PVC (potential volume change) Meter TS 5:6". It is reported that tests with this new device can be completed in two hours or less, and even though an individual is unfamiliar with or inexperienced in soil engineering and classification he can quickly determine the degree of volume change in the soil sample with this tester.

Elvin F. Henry *(left)* and James R. Simpson of FHA's Architectural Standards Division displaying new field device for testing soils.

W. D. Tucker

K. V. Fiske

J. L. Gilliam

William D. Tucker, who has been connected with the John Blue Co., Inc., Huntsville, Ala., for more than 25 years, has been elected to the office of executive vice-president of the firm.

Kenneth V. Fiske has been appointed director of farm operations for Velsicol Chemical Corp., Chicago, Ill. In his new position he will be responsible for the administration of the company's research farm located near Woodstock, Ill. He will assist in market development and serve as liaison between research and other departments. He previously was agricultural engineer on the farm department staff of the National Safety Council.

Jack L. Gilliam has been appointed marketing representative for the Detroit, Mich., area of the Nashville Division of Avco Corp. His most recent assignment was general factory manager for Massey-Ferguson Co., Detroit, Mich.

Joe E. Clayton has joined the staff of the Cotton Mechanization Investigations, AERD, ARS, USDA, at Stoneville, Miss., following his graduation from Clemson College. His work is primarily in the field of cotton harvesting research.

C. M. Shepstone is now located in Toledo, Ohio, where he is a sales engineer at Dana Corp. He formerly was a sales representative for Warner Electric Brake & Clutch Co.

Cecil W. Chapman, state conservationist, SCS, USDA, Athens, Ga., was honored recently by the Soil Conservation Society of America at its annual meeting in Canada by his selection as a "Fellow" member.

George B. Hill has been called to serve as president of a new mission of the Church of Jesus Christ of Latter Day Saints to be organized, with headquarters in the Washington, D. C., area. He will assume his new duties about January 1, and will direct the activities of about 150 missionaries throughout Pennsylvania, Virginia, West Virginia, Maryland, Delaware, and the District of Columbia. He was previously associated with Perfection Steel Body Co. and Cobey Corp. of Galion, Ohio, in addition to operating a private consulting business.

Deane G. Carter, professor emeritus of farm structures, University of Illinois, left this country in September for a one or possibly two-year assignment to Turkey. He will be agricultural engineering advisor in the establishment of a new "rural" university under the ICA Contract program with the University of Nebraska.

Fred M. Crawford, formerly a salesman with Tazewell Builders, has accepted the position of assistant farm electrification engineer with Wisconsin Electric Power Co., Milwaukee.

Glenn I. Johnson, extension agricultural engineer and project leader, University of Georgia, Athens, has accepted a foreign appointment. He is one of six from the University working with the National School of Agriculture in Cambodia, under the University's contract with ICA and the Cambodian government.

Paul R. Hoff, extension agricultural engineer, Cornell University, Ithaca, N. Y., will be working for ICA in Brazil for the next two years. His assignment is the development of an extension program in agricultural engineering.

William C. Little recently has joined the staff of the Piedmont Experiment Station, Watkinsville, Ga. He previously was an agricultural engineer with the USDA Soil and Water Conservation Research Division, Auburn University.

George R. Schultz advises that he is now located in Minnesota, where he is associated with the Cornelius Co. He formerly was located in Iowa in the development engineering department of Cherry-Burrell Corp., as a design engineer.

Norman L. Beigh, who formerly held the position of project engineer with J. I. Case Co., Churubusco, Ind., has accepted the position of product engineer with the Fort Wayne (Ind.) Division of Bowser, Inc.

Wilmot W. Irish has accepted the position of extension specialist in dairy housing at Cornell University, Ithaca, N. Y. He came to Cornell from the University of Connecticut, Storrs, where he was an extension agricultural engineer.

John M. Chambers has resigned his position as chief agricultural engineer, Europe, with Massey-Ferguson, Ltd., England, to become a consultant. He will specialize in farm, horticultural, estate and forestry machinery, and also in industrial machinery where it relates to the use of basically farm tractors or "off-the-road" self-propelled vehicles.

M. G. Bekker is now with the Defense Systems Division of General Motors Corp. as head of the Land Mobility Laboratory. He formerly was chief of the Land Locomotion Research Branch, R. and D. Division, Ordnance Tank Automotive Command.

O. H. Bell has been promoted from vice-president and general manager to president of Pacific Tractor and Equipment, Ltd., Vancouver, B. C., Canada.

George W. Bingley has accepted a position in the Tractor and Implement Division of Ford Motor Co., Birmingham, Mich. He previously was associated with John Deere Harvester Works as a product engineering trainee.

John H. Body, who has been an engineer for Gilbart Associates, Yellow House, Pa., is now associated with Air Products Inc., Allentown Pa., as a project engineer.

Morton M. Boyd is now located in Alliance, Ohio, where he is assistant chief engineer for United Co-Operatives, Inc. He previously was a member of the agricultural engineering department staff at the University of Massachusetts.

J. E. Clayton

C. M. Shepstone

Albert L. Brodie, assistant manager of technical services, Texaco Inc., has been appointed director of technical services.

George H. Daskal, Jr. has been promoted from works manager to secretary of Perfection Gear Co. of Harvey, Ill.

L. E. Dempsey, formerly with Dunbar Kapple, Inc., has been appointed vice-president of Price Brothers, Chicago, Ill.

Adolfo H. Eschenwald has been transferred from the University of Puerto Rico, Mayaguez, to the Lajas Experiment Substation, University of Puerto Rico, Lajas.

Thomas Evans has been promoted from chief product engineer to manager of product engineering for J. I. Case Co., Bettendorf, Iowa.

David F. Whitesell has accepted the position of city engineer for the City of Galax, Va. He previously was electrical development engineer for Meriwether Lewis Electric Co-op.

Irvin R. Fisher has been promoted from buyer to manager, farm buildings department of Cooperative Grange League Federation Exchange, Inc., Ithaca, N. Y.

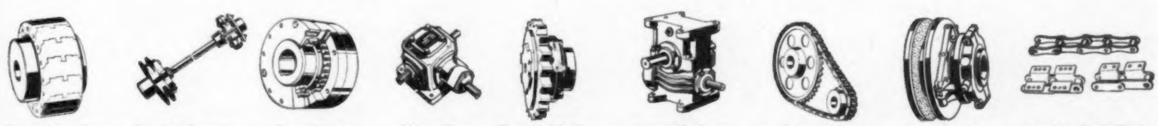
Emmett M. Griffith has accepted the position of field engineer with the Weather-Matic Sprinkler Division of Telsco Industries in San Francisco, Calif. He was formerly located in Texas, where he was southwest representative for The Skinner Irrigation Co.

John P. Hermanson, formerly research engineer, Caterpillar Tractor Co., is now a project engineer with the New Idea Division of Avco Corp., Coldwater, Ohio.

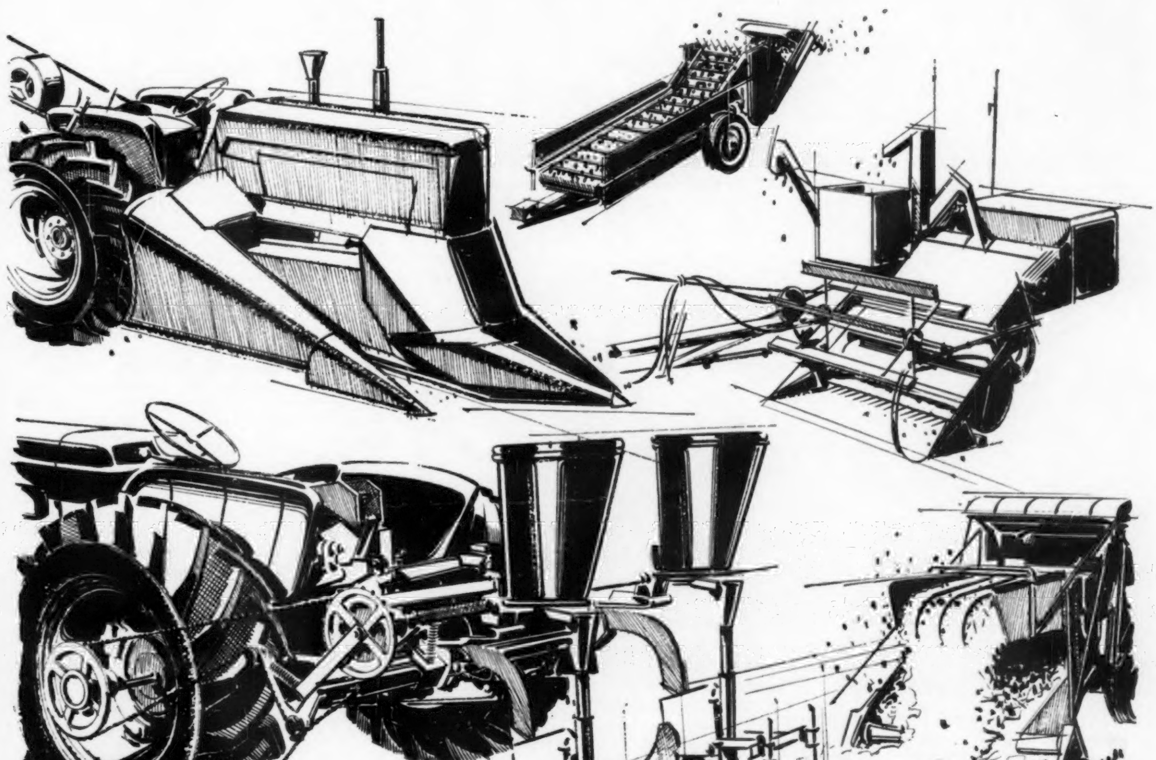
Raymond L. Oldfather has been appointed vice-president of Farmecon Inc., Cedar Falls, Iowa. He was previously its chief engineer.

Charles R. Pepe has joined A. O. Smith Co., Kankakee, Ill., as a field test engineer. He was formerly employed by Schlumberger Well Surveying Corp., as a junior field engineer.

Ray I. Throckmorton, Jr., who has been employed in farm practice research at International Harvester Co., Chicago, Ill., has been appointed supervisor of crop production equipment.



Nylon Coupling • Morflex Coupling • Cam Clutch • Miter Box • Torque Limiter • Speed Reducer • Roller Chain • Over Center • Double Pitch Chain



Alabama Section

The Alabama Section held its fall meeting on October 21 and 22 at Auburn University. The meeting opened Friday morning with a tour of Orr Industries in Opelika. The formal program began at noon with a luncheon in the Union ballroom. The opening day's program included talks by W. R. Walker, TVA electric development specialist; T. G. Amason, SCS planning party leader; L. E. Funchess, director of buildings and grounds at Auburn University; and I. F. Reed, agricultural engineer at the National Tillage Machinery Laboratory, Auburn. J. L. Butt, executive secretary of ASAE, stressed in his address the fact that a good promotion plan is needed to interest high school graduates in the field. Also included on the program was the showing of the new ASAE film, "Agricultural Engineering — The Profession With a Future." A business meeting concluded the two-day meeting that was attended by some 50 Section members.

Alabama Section officers present J. L. Butt, executive secretary of ASAE, with identification badge, preceding the Section meeting October 21 and 22. Left to right are F. M. Gambrell, vice-chairman, Butt, and T. E. Corley, chairman

Virginia Section

The Virginia Section held its annual meeting on November 4 and 5 at Virginia Polytechnic Institute. The technical program included discussions on watershed development progress in Virginia and how the agricultural engineer fits into this activity; the use of aluminum in farm structures; efficient dairy layouts; and the fuel cell electric powered tractor. There were also talks on the selection of materials handling systems, by E. S. Coates, North Carolina extension agricultural engineer, and on current crop drying recommendations, by J. B. Stere, product manager, crop dryers, New Holland Machine Co. The following officers were installed at the business meeting on November 5 to lead the Section in 1961: R. G. Bass, chairman; H. T. Hurst, vice-chairman; W. E. Lucas, vice-chairman; D. R. Burrowbridge, vice-chairman; and J. P. Walker, secretary-treasurer.

Hawaii Section

In an effort to promote the agricultural engineering profession and to increase its membership, the Hawaii Section held a two-day field tour meeting October 20 and 21 at the University of Hawaii. Called the "First Agricultural Engineering Coordinating Conference," the meeting was planned to attract attendance from plantation managers, developers of sugar cane, pineapple and other agricultural machines, and other prospective members. The conference was considered most successful with a registration of 84 persons, representing all islands. Two visitors from South America were also present.

October 20 was devoted to lectures and demonstrations on field spraying by air. The day's activities were climaxed with a dinner at the Princess Kaiulani Hotel, with 96 in attendance. L. V. Hass, vice-president, Libby, McNeill and Libby, was the guest speaker, addressing the group on challenges for agricultural engineers. On October 21 the group took several tours where they observed agricultural operations.

ASAE MEETINGS CALENDAR

December 20 — MISSISSIPPI SECTION, Sedimentation Laboratory, Oxford, Miss.
February 6-8 — SOUTHEAST SECTION, Robert E. Lee Hotel, Jackson, Miss.
February 25—MICHIGAN SECTION, Hudson's Northland, Detroit, Mich.
March 30-31 — PACIFIC COAST SECTION, Davis, Calif., area.
April 7-8 — MID-CENTRAL SECTION, St. Joseph, Mo.
April 14-15 — ROCKY MOUNTAIN SECTION, University of Wyoming, Laramie.
April 14-15 — SOUTHWEST SECTION, Grim Hotel, Texarkana, Texas.
June 25-28—ANNUAL MEETING, Iowa State University, Ames, Ia.
August 20-23—NORTH ATLANTIC SECTION, University of New Brunswick, Fredericton, N. B., Canada.
December 13-15 — WINTER MEETING, Palmer House, Chicago, Ill.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Southeast Section

The Southeast Section will hold its annual meeting February 6 to 8 at the Robert E. Lee Hotel, Jackson, Miss., in conjunction with the meeting of the Association of Southern Agricultural Workers.

Mississippi Section

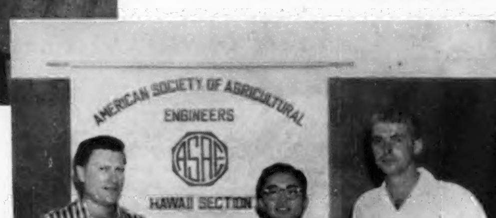
The Mississippi Section will hold a meeting on December 20 at the Sedimentation Laboratory, Oxford, Miss. The tentative program will include a morning business meeting; lunch; the showing of the new ASAE motion picture "Agricultural Engineering — The Profession With a Future"; and a discussion on what agricultural engineering has to offer in the four major fields —power and machinery, electric power and processing, structures, and soil and water conservation. The day's activities will conclude with a tour of the Sedimentation Laboratory.

Washington, D. C. Section

The Washington, D. C. Section held a luncheon meeting on October 14 at which H. S. Pringle, Federal Extension Service, spoke on "The Society's Five-Step Plan." He appealed to the members to interest themselves in recruiting the youth of the area so that they may secure training in agricultural engineering as a career. The new ASAE motion picture "Agricultural Engineering — The Profession With a Fu-

(Continued on page 836)

***(Above)* Virginia Section officers for 1961 shown from left to right are: R. G. Bass, chairman; H. T. Hurst, vice-chairman; D. R. Burrowbridge, vice-chairman; J. P. Walker, secretary-treasurer; and W. E. Lucas, vice-chairman**



***(Right)* Displaying newly designed Hawaii Section banner at a recent Section meeting are its officers *(left to right)* Harry Cerny, chairman; Jaw-Kai Wang, secretary-treasurer; and Eugene Morgan, vice-chairman**

MANUFACTURERS' LITERATURE

Literature listed below may be obtained by writing the manufacturer.

Fabric Film Sample Packet

Griffolyn Co., 6813 Dixie Dr., Houston, Texas — Fabric film packet with a variety of agricultural utilizations, including protective covers for silos, machinery, feed troughs, and poultry houses. The light, flexible material is primarily polyethylene, reinforced by interwoven nylon fibres.

Effluent Resistance Recorder

LKB Instruments, Inc., 4840 Rugby Ave., Washington 14, D.C.— Bulletin 5300-EO1 gives information on stability, linearity, sensitivity, and accuracy of the LKB 5300 conductolyzer—an instrument for automatic resistance measurements of streaming solutions.

Packaged Bearings Bulletin

Tann Bearing Co., 3750 E. Outer Dr., Detroit 34, Mich.— A 4-page, 2-color bulletin, No. B5-60, illustrates and describes new line of packaged bearings designed for interchangeability with ball bearings in bore and shaft requirements. Included are specifications and life expectancy tables, plus a cutaway drawing.

Torque Flywheel PTO Bulletin

Transmission Division, Clark Equipment Co., P-200, Jackson, Mich.— A 4-page, 4-color bulletin, Form No. FT200 describes the P-200 flywheel PTO. Dimensions are indicated on transverse and longitudinal scale drawings, and the unit is illustrated by a cutaway photograph and drawing. A variety of applications is suggested and design features and tips on application are included.

Draintile Testing Machine

Tester Division, Forney's Incorporated, P.O. Box 310, New Castle, Pa.— A 2-page data sheet describes the drain and sewer tile testing machine for testing the smaller sizes of drain and sewer tile — both clay and concrete. Also included are dimensions, weights, and shipping data.

Diesel Farm Tractor Brochure

Kramer-American Corp., Dept. K, 3932 Wilshire Blvd., Los Angeles 5, Calif.— A 4-page, illustrated brochure describes the technical and operational features of the German-made model KLS 140 tractor. Also included is information on the air-cooled diesel engine, as well as a cutaway drawing of the hydraulic lift.

Conveyor Drives Bulletin

Maurey Manufacturing Corp., Service Division, 2907-23 S. Western Ave., Chicago 16, Ill.— No. FV-1, a 2-page, 2-color bulletin, describes and illustrates a steel conveyor drive designed for handling bottles, boxes, crates, cans and containers of heavy and light weights. Full dimensional and price data are furnished.

Universal Joint Catalog

Mechanics Universal Joint Division, Borg-Warner Corp., 2020 Harrison Ave., Rockford, Ill.— Catalog No. J-1960-1 describes and illustrates universal joints for the agricultural and implement fields. Included are engineering data, agricultural equipment status for power take-offs, complete joint specifications, servicing instrhctions, and ordering information.

Planting Machines Literature

Heinrich Weiste & Co. GMBH, Sieningsen via Soest/Westfalen, Germany—Literature on Unimog planter for sugar cane, cassava, tobacco, corn, and vegetables and Accord line of planting machines and cultivating equipment.

Ferrous Forgings Booklet

American Brake Shoe Co., Department A, 530 Fifth Ave., New York 36, N. Y.— A 28-page booklet describes company facilities and line of drop, upset, and press forgings.

Caterpillar Literature

Caterpillar Tractor Co., Advertising Division, Peoria, Ill., offers the following:

Form No. DO39, an 8-page booklet entitled "Controlled Water Works for You" tells what is being done and can be done to assure that the maximum benefits can be realized from water control in all parts of the nation.

Form No. DO23, an 8-page brochure entitled "Looking Ahead," discusses the research and development activities of the company's engineering department, research department, product division, and market division.

Rotary Cutter Literature

E. L. Caldwell & Sons, 3204 Agnes St., Corpus Christi, Texas — Literature on complete line of rotary cutters for brush and field crops.

Soil Improvement Booklet

Crucible Steel Co. of America, Oliver Bldg., Pittsburgh, Pa. — A 20-page, 2-color booklet entitled "Soil Improvement with Crucible Agricultural Steels."

Molded Products Brochure

The Dayton Rubber Co., Molded Products Sales Division, Three Rivers, Mich.— A 2-color, 6-page brochure describes and illustrates molded products — rubber-to-metal, molded rubber, rubber-to-fabric, mandrel built, and molded urethane.

New Concept in Manure Spreading

New Idea Farm Equip. Co., Coldwater, Ohio, has developed a separate manure spreading unit which can be operated be-

hind most farm trucks with rear dump flat bed box.

The truck, equipped with an automatic hitching mechanism, is quickly coupled to the spreader by simply backing into it. After the truck is emptied the driver disconnects the spreader by pulling a cable release inside the truck cab. The spreader remains in the field, ready for the next load. As required, it can be towed from place to place easily.

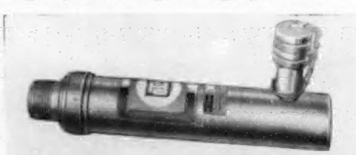
New 4-Wheel Drive Tractor-Shovel

J. I. Case Co., Racine, Wis., has introduced its biggest, most powerful model in its line of 4-wheel drive loaders. Called

the W-12, the new model reportedly has a carry capacity of 9000 lb and a break-out capacity of 23,500 lb. Features include torque converter drive said to automatically and instantaneously triple engine output torque to meet increasing loads; constant mesh transmission that provides speeds from 0 to 23 mph in forward or reverse through three speed ranges; a power transfer differential for all four drive wheels; power shift; power steer; and power brakes.

New Line of Hydraulic Rams

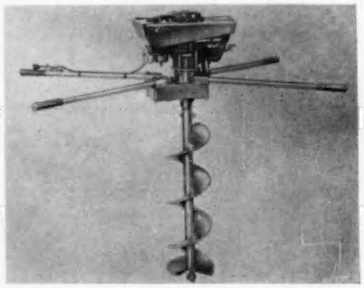
Owatonna Tool Co., 359 Cedar St., Owatonna, Minn., has introduced a new line of single-cylinder, single-acting hydraulic rams



available in nine sizes, from $1\frac{11}{16}$ in. long with $\frac{3}{8}$-in. stroke, to one $20\frac{1}{4}$ in. long with $13\frac{1}{2}$-in. stroke. Capacities range from 2 to 50 tons with maximum working pressures of 8,650 and 10,000 psi.

Portable Power Posthole Drill

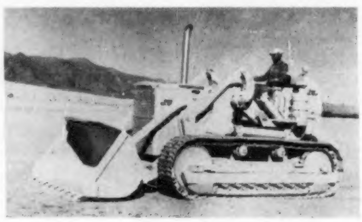
The General Equipment Co., Owatonna, Minn., has introduced a new portable two-man power earth and ice drill. The new



machine is powered by a $2\frac{1}{2}$-hp, 2-cycle, air-cooled engine with automatic rewind starter, straight-in-line drive with balanced torque control and centrifugal clutch which disengages at idle speeds.

New Power-Shift Track-Type Tractors

Caterpillar Tractor Co., Peoria, Ill. has announced two new track-type tractors equipped with power shift transmission.



Model 977H is powered by a new turbocharged diesel engine and is rated at 150 hp. The second model is the 755H rated at 100 hp and is powered by a turbocharged 4-cylinder diesel engine.

Single lever shifting during all phases of the work cycle is permitted in both models by the new power shift transmission. See page 804. The master clutch has been eliminated. Operators can choose between a high and low work range, each of which has two gear speeds forward and reverse. Live hydraulic power to the loader mechanism is provided by the pump being driven directly from the engine flywheel.

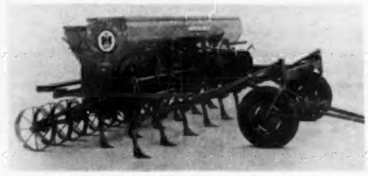
Precision Row-Crop Thinner

Blackwelder Manufacturing Co., Rio Vista, Calif., has announced the development of a new high precision row-crop thinner. The new unit is designed to cut out precise spacings between plants, depending

on the setting. The design consists of from two to six ground-driven thinners individually suspended on the rear tool bar of a tractor. The thinners have only two moving parts. Specially-constructed wheels leave a completely undisturbed block of soil and a plant, while a knife wheel mounted within cuts away excess plant growth.

Drill Designed for Erosion Control

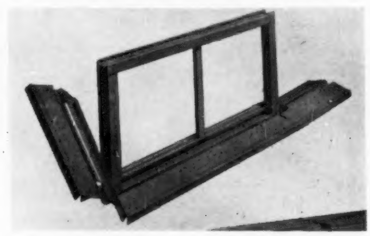
International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill., has announced its new McCormick No. 150 shovel



press drill, for deep seeding and work in heavy trash. Equipped with a $1\frac{3}{4}$ bushel per foot capacity seed hopper, the new unit's shovel-type openers are designed to sow seed at moisture level with little disturbance to surface cover. The unit reportedly leaves a trash-laced ridge that helps trap and hold moisture, while reducing soil blowing and water erosion. The new drill is available in 12 and 14-ft sizes with 10 and 14-in. spacings (10 x 14, 14 x 10, 12 x 14, and 16 x 10). A $1\frac{1}{4}$-in. square press-wheel gang axle helps prevent slippage of the press wheels.

Wrap-Around Window Form

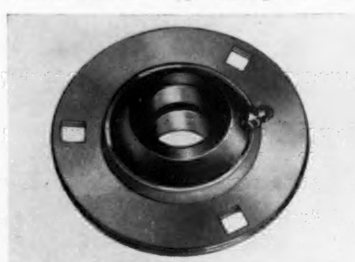
Rolite Mfg. Inc., Newell and Cambria Sts., Lancaster, N. Y., has announced a new wrap-around window form designed for



standard size basement windows. As an integral part of the window, the wrap-around form and head section provides an attractively cased window opening of durable primed steel. Forms are available in sizes to fit poured concrete or block wall thicknesses of $7\frac{5}{8}$, 8, 9, $9\frac{5}{8}$ or 10 in.

New Series of Center Flange Bearings

Triangle Mfg. Co., Oshkosh, Wis., has introduced a newly-designed series of heavy-duty self-aligning center flange bearings. Three basic sizes carry either pressed steel or cast iron sleeve type bearing ball units.



All standard shaft sizes from ½ to 1¾ in. are available, with a choice of oil or grease lubrication. Units are interchangeable with ball bearing flange units. Bolt holes can be varied in size, shape, number or location to meet special requirements.

Moisture Resistant Temperature Control

Fenwal Incorporated, Pleasant St., Ashland, Mass., has developed two new adjustable, moisture-resistant temperature controls designed for volume applications where humidity, condensation and similar environments would otherwise cause problems. Both units are completely adjustable throughout their temperature range, and have the fraction-of-a-degree sensitivity. Model 17100-161 has a range of 0 to 175 F; Model 17100-162 has a range of 0 to 225 F.

New SP Combine Announced

Massey-Ferguson Ltd., 915 King St., W., Toronto, Ontario, Canada, has announced its Super 92 self-propelled combine which features six open bottom straw walkers in a 48-in. wide walker body. Motion of the shaker shoe and the motion of the grain pan under the walker are opposed. This feature reportedly reduces vibration and breaks up blanketing of crop as it moves from pan to shoe. Design of the shaker shoe allows relatively clean grain to fall on the front of the chaffer sieve, a feature said to spread the load uniformly, thereby improving efficiency and reducing grain loss. The unit is powered by a 6-cylinder Chrysler industrial engine, with a rated brake horsepower of 75 at 1865 rpm.

Cane Harvester Features Special Design

J and L Engineering Co., Inc., Jeanerette, La., has developed a cane harvesting machine that requires only one operator and two other men to burn and load the cut cane. The machine uses three sharp, even-

(Continued on page 837)

...With ASAE Sections

(Continued from page 832)

ture" was also shown. E. G. McKibben was appointed chairman of the Career Activities Committee and other committee chairmen appointed were: Chester J. Francis, chairman, Professional Registration; Hajime Ota, chairman, Membership Committee; and J. P. Schaenzer, chairman, Publicity Committee.

Lowell E. Campbell, secretary-treasurer of the D. C. Council of Engineering and Architectural Societies announced that they will again sponsor an Engineers, Scientists and Architects Day on February 23. It will be held at the Presidential Arms with a full day's program. The featured speaker will be S. W. Herwald, director of research, Westinghouse Electric Corp., Pittsburgh, Pa. His subject will be "World Around Us—New Materials."

A meeting was also held on November 4 at the Student Union of the University of Maryland in the form of a buffet luncheon meeting. National President Lloyd W. Hurlbut, chairman, agricultural engineering department, University of Nebraska, was the featured speaker.

Michigan Section

The Michigan Section will hold its winter meeting on February 25 at Hudson's Northland, Detroit.

Pacific Northwest Section

The Pacific Northwest Section has elected the following officers for the year 1961: L. R. Swarner, chairman; W. H. Knight, chairman-elect; D. E. Kirk, first vice-chairman; D. A. Randall, second vice-chairman; D. L. Bassett, third vice-chairman; Gordon Timbers, fourth vice-chairman and chairman of student group; and C. H. Pair, secretary-treasurer.

Connecticut Valley Section

The Connecticut Valley Section has elected the following slate of officers for the year 1960-61: James H. Whitaker, chairman; William J. Good, Jr., senior vice-chairman; William H. Collins, junior vice-chairman; and Thomas W. Stone, secretary-treasurer.

At 3:00 p.m. on November 30 Section members met at the Public House, Sturbridge, Mass., to start a tour of two dairy housing systems. The group returned to Public House for a 7:00 p.m. dinner meeting, at which discussions on dairy housing were given by Preston Roberts. Robert Benson, and Kaye Andrews, representing industry, education, and farming.

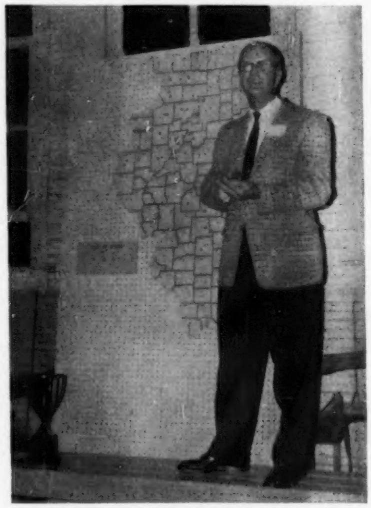
Adopts Section Seal

The Florida Section has adopted an official Section seal, which it believes is the first of its kind to be adopted by any section of ASAE. According to A. M. Pettis, Section secretary, first use of the new seal will be on certificates awarded to past-chairmen and perhaps other Section officers upon completion of their terms of office. Authorization to use the seal was made possible by the Council of ASAE, upon a request from the Florida Section.

Florida ASAE *Section*

Pacific Coast Section

The Executive Committee of the Pacific Coast Section met at the University of California, Riverside, on September 1, at which time Section reorganization into Chapters was discussed and acted upon. The newly formed Chapters of the Pacific Coast Section will be defined as: Northern California-Western Nevada; Southern California; and Arizona. All members of ASAE residing in a Chapter area will be members of that chapter. Chapter officers and committees will be as follows: Chairman, vice-chairman and meetings coordinator; secretary-treasurer; committees—Membership, Publicity and Promotion, Meetings, and Nominating.



A novel get-acquainted idea was used during the annual student-staff stag party held recently by the Illinois Student Branch of ASAE. R. C. Hay, professor of agricultural engineering at the University of Illinois, is shown placing a pin on the map indicating the "home county" of each agricultural engineering student as he introduced himself

The officers and nominating committee will be elected by the Chapter and the other committees appointed by the Chapter chairman. The first slate of officers for each chapter will be appointed by the Section chairman, and the first nominating committee will be appointed by the Chapter chairman. The officers will serve for one year, corresponding with the period between annual Section meetings. Chapter chairmen will be members of the Section Executive Committee and chairmen of Chapter committees will be members of corresponding Section committee.

EVENTS CALENDAR

January 9-13—*International Congress and Exposition* of the *Society of Automotive Engineers,* Cobo Hall, Detroit, Mich. Contact SAE, 485 Lexington Ave., New York 17, N. Y., for additional information.

January 17—*Farm Equipment Institute Production and Marketing Dept., Winter Meeting,* Dinkler Plaza Hotel, Atlanta, Ga. Write to FEI, 608 S. Dearborn St., Chicago 5, Ill., for further information.

February 5-11—*National Electrical Week.*

February 12-16—*National Rural Electric Cooperative Assn. Annual Meeting,* Dallas, Texas.

February 13-16—*American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Semiannual Meeting,* Conrad Hilton Hotel, Chicago, Ill. Information may be obtained from ASHRAE, 234 Fifth Ave., New York 1, N. Y.

February 22-23—*Seminar on Automation and Numerical Control,* Bond Hotel, Hartford, Conn. Sponsored by the American Society of Tool and Manufacturing Engineers, 10700 Puritan Ave., Detroit 38, Mich.

February 23—*Engineers, Scientists and Architects Day,* Presidential Arms Hotel, Washington, D.C., sponsored by D. C. Council of Engineering and Architectural Societies.

February 28 - March 1—*Ninth Annual National Dairy Engineering Conference,* Michigan State University, East Lansing, Mich. Contact Carl W. Hall, Agricultural Engineering Dept., MSU, East Lansing, Mich., for additional information.

March 2-7—*International Technical Congress of Agricultural Machinery,* Paris, France. For information write to: Congres International Technique du Machinisme Agricole, 19, Rue Jacques Bingen, Paris XVII, France.

March 5-9—*Sixth Annual Gas Turbine Conference and Products Show,* Shoreham Hotel, Washington, D. C. Sponsored jointly by the Gas Turbine Power Division, The American Society of Mechanical Engineers, and the U. S. Department of Defense. For details contact ASME, 29 W. 39th St., New York 18, N. Y.

March 7-12—*32nd International Machinery Show,* Paris, France. For additional details write to Robert de Wilde, agricultural attache, 1001 Connecticut Ave., N.W., Washington 6, D.C.

April 17-19—Eighth *National Watershed Congress,* Ramada Inn, Tucson, Ariz. Details may be obtained from The National Association of Soil Conservation Districts, League City, Texas.

April 17-21—*American Welding Society 42nd Annual Convention,* Commodore Hotel, 42nd St., New York, N. Y. For further details write to Information Center, AWS, 33 W. 39th St., New York 18, N. Y.

April 20-22—*76th Annual Convention of the Illinois Society of Professional Engineers,* Peoria, Ill. Information may be obtained from ISPE, 1108 East London Ave., Peoria, Ill.

June—*First International Conference on the Mechanics of Soil-Vehicle Systems,* Turin, Italy. For further information write to: M. G. Bekker, national secretary for the Conference, U.S. Army Ordnance Tank-Automotive Command, 1501 Beard, Detroit 9, Mich.

June 9-17—*European Congress of Chemical Engineering and ACHEMA Congress,* Frankfurt am Main. Information is available from DECHEMA, Frankfurt am Main 7, Postfach.

June 11-15—*American Society of Mechanical Engineers Summer Annual Meeting,* Statler-Hilton Hotel, Los Angeles, Calif. Contact ASME headquarters, 29 W. 39th St., New York 18, N. Y., for information.

June 25-30—*American Society for Testing Materials Annual Meeting,* Chalfonte-Haddon Hall, Atlantic City, N. J. Write to ASTM headquarters, 1916 Race St., Philadelphia 3, Pa., for information.

. . . New Products

(Continued from page 835)

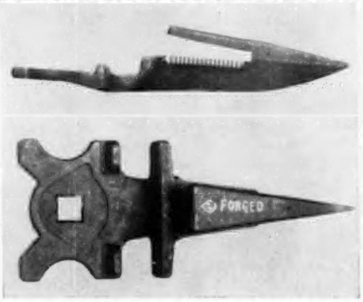
wearing rotary blades, and reportedly is able to harvest the cane without splitting the stubble or choking the machine. An adjustable, convex blade, 32 in. in diameter, is rotated by a chain drive at the bottom of the machine to cut the cane just below the ground level. Twin rotary blades, 18 in. in diameter, at the top of the harvester are chain driven to cut the cane tops. In order to maintain quality performance it is reported that the blades, constructed from a special steel plate, are machined on a vertical lathe to provide a cutting face which is then hardened with a tungsten carbide surface.

New Seal Material Announced

Armstrong Cork Co., Industrial Division, Lancaster, Pa., has developed a new gasketing material for use in hot oil applications. The new material designated NO784 is a special Buna N rubber compound that performs in oil up to 350 F. Applications reported for the new material are transmission seals and oil seals.

New Forged One-Piece Guard

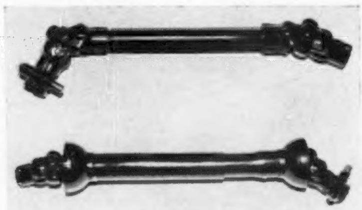
Buchanan Steel Products Corp., Buchanan, Mich., has developed a new heat-treated, forged-steel work guard. Being of one-



piece design, the guard has a self-contained serrated edge ledger surface forged in, thereby eliminating a ledger plate. The company reports that at present the unit is being manufactured for the Oliver Corp.

Stamped Universal Joints

Chain Belt Co., Agricultural Chain Div., 13943 Park Ave., Dolton, Ill., has introduced a new plain-bearing stamped uni-



versal joint designed for agricultural implement drives. The new joint is made entirely of heat-treated stampings and is suitable for light duty PTO drives and intermittent service.

Double assemblies can be furnished with integral safety shields mounted on nylon bearings. These joints are also available as single assemblies with bore and keyway to customers' requirements.

The following bulletins have been released recently. Copies may be obtained by writing to author or institution listed with each.

A Survey on Methods of Picking Olives for Pickling and for Oil, by Meir Bensoussan and Gabriel Garbi. The Israel Institute of Productivity, 22, Harakevet St., Citrus House, Tel-Aviv, Israel.

Safety Zone Within Your Home. Structural Clay Products Institute 1520 18th St., N. W., Washington 6, D. C.

Farm Buildings Association Report of the Fourth Winter Conference (1959) and the Fourth Annual Conference (1960). Farm Buildings Association, Westfield, Braunston, Oakham, Rutland, England.

The following bulletins are available from the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, England.

- *Supplementary List of Publications,* May, 1960.
- *Agricultural and Horticultural Engineering Abstracts.* Vol. X, 1959, and Vol. XI, 1960. Published quarterly.

Reports on Tests of —

- *Nuffield Universal Model 3 DL Diesel Tractor.* January, 1960. No. 242.
- *Nuffield Universal Model 3 DL Diesel Tractor.* January, 1960. No. 243.
- *Nuffield Universal Four Diesel Tractor.* January, 1960. No. 244.
- *Alvan Blanch 8/10-CWT Meal Mixer.* January, 1960. No. 245.
- *Fordson Power Major Diesel Tractor.* February, 1960. No. 246.
- *"Gloster" Forage Harvester (in-line rear-delivery model).* October, 1959. No. 247.
- *Huggan "Waterboy" Irrigation Equipment.* February, 1960. No. 248.
- *Nuffield Universal Four Diesel Tractor.* January, 1960. No. 249.
- *Nuffield Universal Model 3 DL Diesel Tractor.* January, 1960. No. 250.
- *Pirelli 11-28 "Cinturato" Tractor Tyre.* December, 1958. No. 251.
- *Blanch-Bettison 2BX Grain Drier.* January, 1960. No. 252.
- *McCormick International Farmall B-450 Diesel Tractor.* March, 1960. No. 253.
- *Penney and Porter Series II 5/21 Grain Drier.* March, 1960. No. 254.
- *Bomford Reversible Plough.* May, 1960. No. 255.
- *FisherHumphries "Superfurrow" Mounted 3-Furrow Plough.* May, 1960. No. 256.
- *David Brown 950 Implematic Livedrive Diesel Tractor with 13-28 tires.* January-February, 1960. No. 257/BS.
- *David Brown 950 Implematic Livedrive Diesel Tractor with 11-32 tires.* January-February, 1960. No. 258/BS.

The following bulletins are available from the Agricultural Machinery Administration, Province of Saskatchewan, Dept. of Agriculture, 7th and Hamilton, Regina, Sask., Canada:

Reports on Tests of —

- *McCormick No. 163 Self-Propelled Windrower.* May, 1960. No. 759.
- *Du-Al Windrower Swather.* June, 1960. No. 859.
- *Owatonna Model "D" Windrower.* May, 1960. No. 959.
- *Renn No. 24 Grain Roller.* July, 1960. No. 1059.
- *Peerless 601C^{S} Grain Roller and Mixer Combination.* July, 1960. No. 1159.
- *Automatic No. 400 Grain Roller.* July, 1960. No. 1259.

Electric House Heating, REA Bulletin 142-1. September, 1960. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price, 20 cents.

Science in the Americas. 1959. Papers presented at Science Section of the 7th National Conference of the U. S. National Commission for UNESCO. National Academy of Sciences, 2101 Constitution Ave., Washington 25, D. C.

The following bulletins are available from Michigan Agricultural Experiment Station, Michigan State University, East Lansing:

- *Unloading Soft-Fleshed Fruit From Bulk Boxes,* by I. J. Pflug and D. H. Dewey. Article 43-15, August 1960. Reprinted from the Quarterly Bulletin, Vol. 43, No. 1, pages 132-141.
- *Storage of High Moisture Corn in Upright Silos and Its Feeding,* by C. A. Lassiter, J. S. Boyd, and E. J. Benne. Article 43-6. August 1960. Reprinted from the Quarterly Bulletin, Vol. 43, No. 1, pages 58-66.

The following bulletins are available from the Ontario Department of Agriculture, Parliament Buildings, Toronto, Ontario, Canada:

- *Farm Drainage Assistance.* Publication 4. Revised July 1960.
- *Irrigation Practices for Ontario.* Publication 176. Revised August 1960.
- *Farm Drainage.* Publication 501. Revised June 1960.
- *Drainage Guide for Ontario.* Publication 29. September 1960.

A Bibliography of Farm Buildings Research, 1945-1958 — Part III, Buildings for Poultry. Published 1960. Agricultural Research Council, Cunard Bldg., 15, Regent St., London, S.W.1., England. Price, 4/6d, by post 4/11d.

Pelleted Feeds: Effect of Hull and Fiber on Gain and Efficiency of Swine, by W. E. Dinusson, P. A. Nystuen, D. W. Bolin, and C. N. Haugse. Research Report No. 2. September 1960. North Dakota Agricultural Experiment Station, Fargo, N. D.

Harvesting Grain Sorghum, by J. B. Kelley, C. K. Kline, and Woodrow Coots. Leaflet 237. University of Kentucky, Cooperative Extension Service, Lexington, Ky.

How Kentucky Rural Electric Cooperatives Are Controlled, by Wendell C. Binkley and Eldon D. Smith. Circular 571. University of Kentucky, Agricultural Experiment Station, Lexington, Ky.

Ultrasonic Welding. American Welding Society, 33 W. 39th St., New York 18, N. Y. Price, $1.50.

Correlation of Climatological Data with Water Requirement of Crops, by W. O. Pruitt. 1959-60 Annual Report. Published September 1960. Department of Irrigation, University of California, Davis.

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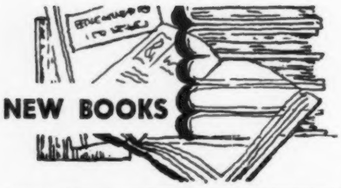


Handbook of Business Mathematics, by William R. Minrath. Cloth. 6 x 9¼ in. xii + 658 pages. Illustrated and indexed. Published by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. $9.85.

Methods for application of mathematics in solving practical business problems are presented in this book which has been organized both for reference and for study. The first section of the book presents the basic mathematical concepts and methods that are required in business mathematics. The second part deals with the methods of business mathematics—those computations that enter, to a greater or less degree, into the everyday operation of practically every business. The third section is devoted to the more specific applications, in such fields as real estate, stocks and bonds, insurance and instalment loans. This third section also contains chapters dealing with calculating machines and computers, as well as the subjects of operations research and the theory of games in their specific application to business problems.

Transformers and Generators for Power Systems, by R. Langlois-Berthelot. Cloth. 5½ x 8¾ in. 541 pages. Illustrated and indexed. Published by Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. $12.00.

This book was written for the engineering student who has a genuine knowledge of physics, for the engineer concerned with design and manufacture, and for the operating engineer. The text is divided into two parts; the first part dealing with the transformer and the second with the synchronous machine. A feature included as one of the appendices is a complete survey of the articles referring to the subject that have appeared in British, American, and French engineering journals, opening up a variety of problems and portraying the great progress made in the last few years.

Engineering Mathematics, by J. Blakey and M. Hutton. Cloth. 5¾ x 8¾ in. 603 pages. Indexed. Published by Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. $10.00.

This book should cover the mathematics needed for a degree in engineering at most universities. It is based on Dr. Blakey's book, "University Mathematics". The more theoretical chapters have been removed and replaced by chapters on numerical solution of equations, statistics, relaxation methods, and Laplace transformations.

Biological and Chemical Control of Plant and Animal Pests, edited by L. P. Reitz. Cloth. 6 x 9½ in. xii + 273 pages. Illustrated and indexed. Published by American Association for the Advancement of Science, 1515 Massachusetts Ave., N.W., Washington 5, D. C. $5.75.

This book is a symposium presented at the 1957 meeting of Section O (Agriculture) of the American Association for the Advancement of Science. It discusses just how much has been accomplished, some of the consequences, and some hint of what more may be done with control measures of plant and animal pests through chemical and biological means. Part I is concerned largely with the stake every citizen has in pest control; Part II relates recent developments and concepts about chemicals, how they are transported, how they kill, and their potential both for plant and animal health, and for eliminating or reducing undesirable forms of life; Part III is on biological control of pests.

Water and Agriculture, edited by Roy D. Hockensmith. Cloth. 6 x 9½ in. viii + 198 pages. Illustrated and indexed. Published by American Association for the Advancement of Science, 1515 Massachusetts Ave., N.W., Washington 5, D. C. $5.00.

This book is a symposium presented at the 1958 meeting of Section O (Agriculture) of the American Association for the Advancement of Science, the American Society of Agricultural Engineers being one of several cosponsors. The subject matter deals with water and agriculture. Hence, it does not include those aspects of water that deal solely with hydroelectric power, navigation, industrial uses, recreation, and pollution. In some of the papers, however, these phases of water are touched on, but only as they are closely associated with water for agricultural uses or as agricultural use of water and land affect these other uses. The papers in Part I deal with water for the future; those in Part II discuss water sources; those in Part III are concerned with water planning and use; and those in Part IV illustrate methods and techniques of water control.

Milk Production and Processing, by Henry F. Judkins and Harry A. Keener. Cloth. 6 x 9½ in. vii + 452 pages. Illustrated and indexed. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. $7.95. *(Continued on page 843)*

PERSONNEL SERVICE BULLETIN

Note: In this bulletin the following listings current and previously reported are not repeated in detail. For further information, see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this bulletin, request form for Personnel Service listing.

Positions Open — July — O-245-623, 256-624. **August** — O-270-625. **September** — O-271-626, 303-627, 303-628, 303-629, 303-630, 273-631, 284-632, 309-634. **October** — O-318-636, 320-637, 322-638, 322-639, 322-640, 325-642, 326-643, 341-644, 347-645. **November**—O-372-646, 392-647, 393-648.

Positions Wanted — July — W-221-53, 252-57, 253-58, 254-59, 257-60. **August** — W-263-61, 264-62. **September** — W-274-65, 281-66, 282-67, 283-68, 294-70, 287-73, 297-74, 300-75. **October** — W-305-76, 314-77, 323-78, 328-79. **November**—W-337-80, 377-81, 367-82, 379-83, 365-84, 383-85, 376-86, 355-87, 394-88.

NEW POSITIONS OPEN

Sales and Service Engineer for area promotion and market management with established manufacturer of grain driers, fruit and vegetable packing house machinery, and bulk handling equipment. Location Midwest after 6 to 12 months at company headquarters in East. Age 25-35. Agricultural engineering degree preferred. Sales training and experience with farm equipment manufacturer or sales organization. Personable and vocal individual who would find non-routine problems stimulating. Able to communicate with top management and production superintendent. Should like travel and be prepared to spend half time in territory. Growth-minded company with maximum opportunity in Midwest for next five years. Could advance to management of sales region and general management. Salary $5000-7000 base plus expenses, incentive and profit sharing. O-407-649

Chief Dairy Engineer to head dairy engineering department with responsibility for design and development of milking machines, pipeline systems, and auxiliary equipment for dairy farms. Established dairy equipment manufacturer in Midwest. BSAE or equivalent. Experience in design and development of any equipment requiring sanitary approval. Creative and otherwise effective in commercial engineering. Unusual opportunity for creative engineer with aggressive organization. Salary open. O-427-650

Project Engineer for basic tractor development group with major full line farm equipment manufacturer in Midwest. Age 32-45. BSAE or BSME. Graduate training desirable. Farm or industrial tractor design and engineering supervisory experience four or more years. Mature, alert and able to supervise others. Could advance to chief project engineer. Salary $12,000 minimum. O-425-651

Agricultural Engineer (assistant instructor) for teaching and research in power and machinery and in agricultural processing, while working on MS degree in Eastern land grant university and experiment station. BSAE or equivalent with better than average grades. Sincere interest in research and desire to earn an MS degree. Small cooperative department staff. Salary $4524, one month vacation. O-429-652

Agricultural Engineer for teaching and engineering consultant on agricultural research buildings and other facilities. South central land grant university and experiment station. BSAE required. MSAE preferred. Must work well with people. Design problems shared with another consulting engineer. Excellent opportunity for advancement. Salary open. O-388-653

NEW POSITIONS WANTED

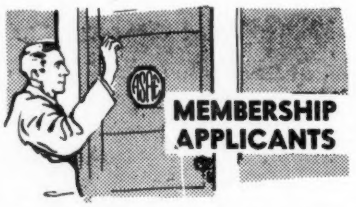
Farm Power Specialist for sales or service in power and machinery, or electrification with manufacturer, distributor or trade association. Any location. Married. Age 30. No disability. BSA, with major in farm mechanics, 1952, Ohio State University. Farm background. Custom hay baling experience before graduation. With an electric utility since 1952 in field work with farmers and farm electrical equipment dealers to 1957. Since 1957, in development, coordination, and evaluation of farm sales program. Available on 30 days notice. Salary open. W-420-89

Agricultural Engineer for sales and service on basis of representing additional products in Northeast or export trade. Married. Age 33. No disability. BSAE, 1950, Kansas State University. With SCS 5 years in drainage, irrigation, and flood control. Since, self employed food broker. Pay basis, commission on sales. W-419-90

Agricultural Engineer for design, development, or research in power and machinery or farm structures with experiment station or consultant. Any location. Married. Age 23. No disability. BSAE, 1959, Iowa State University. Farm background. Active commissioned service with Army Corps of Engineers 6 mo., as maintenance officer in heavy equipment company, with supervision of up to 50 men. Several months with manufacturer in design and research on crop driers. Available on reasonable notice. Salary open. W-415-91

Agricultural Engineer for design, development, or research in power and machinery with manufacturer, processor, or consultant. Any location. Married. Age 38. No disability. BSAE, 1949, University of Minnesota. War non-commissioned service as aviation mechanic and aviation mechanics school instructor over 4 years. Product planning and market research 6 years. Chief engineer of small company 4 years. Chief engineer of medium sized company 8 months. Available on reasonable notice. Salary open. W-422-92

Agricultural Engineer for design, development, research, sales, service, writing or management, in power and machinery, farm structures, or product processing with industry or federal agency. Any location. Married. Age 33. No disability. BSAE, 1951, South Dakota State College. Farm background. Instructor part time one year. Supervisor of service and education for farm equipment factory 4 years. Project engineer 4 years on development of new machines. Chief engineer 2 years on development of farm equipment. Naval enlisted service 2 years as aviation electronics technician mate 2C. Available Feb. 1, 1961. Salary $13,000. W-412-93



The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Andersen, Peter B.— Dev. engr., product dev. dept., Deere & Co., Moline, Ill.

Burton, John R. — Lecturer in civil eng., The University of New South Wales, Australia (Mail) 4906 Enfield Ave., Encino, Calif.

Correia, Joseph F. — Lecturer in agr. eng., University of Rajasthan, India, c/o Agr. eng. dept., Ohio State University, Columbus, Ohio

Cox, Al F. — Tech. serv. rep., Southern Nitrogen Co., Inc., P.O. Box 246, Savannah, Georgia

Dalenberg, William R. — Asst. mgr. of eng., Farm Equip. Res. and Eng. Center, International Harvester Co., 7 So. 600 County Line Rd., Hinsdale, Ill.

Grierson, William — Assoc. chemist, Citrus Experiment Sta., Lake Alfred, Fla.

Hensley, Glenn S. — Editor and gen. mgr., Farm and Power Equipment Magazine, 2340 Hampton Ave., St. Louis 10, Mo.

Hunt, Thomas E., Jr.—(With the U.S. Army) (Mail) 206 Hallbrook Dr., Clarksville, Tenn.

Hutter, Gohl E. — Chief engr., Finco, Inc., 535 Rathbone Ave., Aurora, Ill.

Jacobson, Bernhard — Chief engr., Universal Hoist Co. (Mail) 158 Summit Dr., Cedar Falls, Iowa

Janssen, Gail E. — Farm elecn. advisor, Wisconsin Public Service Corp. (Mail) 2303 Basten St., Green Bay, Wis.

Kassis, Anees Hanna — Laboratory technician (Mail) 98 Poplar St., Carteret, N. J.

McDonald, Clifford T. — Sales engr., Lincoln Engineering Co. (Mail) 2311 Olympia Dr., Bettendorf, Iowa

Moore, Robert M. — President, Moore Farm Building Co., Box 92, Charleston, Ill.

Pinney, Stephen G. — Structural engr., The Champion Co. (Mail) 76 Clinton St., Glastonbury, Conn.

Raisanen, Niilo A. A.—Farm structures engr., Lester's Inc. (Mail) Box 376, Lester Prairie, Minn.

Rogers, James S. — Agr. engr., Southern Piedmont Soil Conserv. Field Sta., (SWCRD, ARS), USDA, P.O. Box 33, Watkinsville, Ga.

Ronning, Richard L.—Proj. engr., alfalfa div., Archer-Daniels-Midland Co. (Mail) P.O. Box 356, Kansas City 41, Mo.

Salter, Emery J.— Admin. trainee, agr. credit dept., Security First National Bank (Mail) 3319 Avalon St., Riverside, Calif.

Steadman, Charles W. — Agr. engr., Mississippi Board of Water Commissioners (Mail) 1905 Aztec Dr., Jackson, Miss.

Stegman, Earl C. — Instr., agr. eng. dept., Michigan State University, East Lansing, Mich.

Sunvold, Wesley D. — Power use advisor, Minnesota Valley Co-op. Light and Power Assn., 501 S. First St., Montevideo, Minn.

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Winzer, David C. — (University of Minnesota) Heron Lake, Minn.

. . . New Books

(Continued from page 840)

This book has been designed to meet the requirements of an orientation course in dairying, and while the material is broad enough to prepare the student for advanced work in dairy science, it is also informative enough to be of use to the reader who never takes another dairy course. The more important phases of milk production and processing are covered, including: The general scope of the industry; the essentials of a successful dairy farm operation; the composition of milk and its secretion; the essentials of herd management; the testing of milk for chemical and sanitary quality; the processing of various dairy products; and the nutritive value of dairy products. Major points in each chapter are covered by questions, and practical problems are also given, that reflect situations the student will encounter in the field.

NEW FILM RELEASES

The following two films are available from Hobart Welding School, Box EW-213, Troy, Ohio:

Arc Welding Electrode Selection. 16 mm. 24 min. Color and sound. This film shows the basic factors to consider in the selection of arc welding electrodes.

From Sea Sands to Better Welding. 16mm. This film shows the actual mining and refining of the minerals used as welding electrode coating ingredients.

The two following filmstrips are available from Successful Farming, Meredith Publishing Co., Des Moines 3, Iowa:

Materials-Handling — Newest Farm Science. The Basics of materials handling in a 71-frame black and white filmstrip with sound commentary.

Materials Handling Systems for Profitable Farming. 60-frame black and white filmstrip with sound commentary shows system application of materals handling principles and techniques.

. . . New Bulletins

(Continued from page 838)

The following bulletins are available from the Institute for Land and Water Management, Wageningen, The Netherlands:

Indirect Evidence for Transcurrent Faulting and Some Examples From New Zealand and the Netherlands, by N. A. De Ridder and G. J. Lensen. Technical Bulletin 15. 1960.

Growth and Water Relations of Tomato — 2. Technical Bulletin 16. 1960.

Size and Shape of Sub-divisions in Drainage Areas, by W. C. Visser. Technical Bulletin 17. 1960.

Drainage of the Polder Districts in the Netherlands, by J. Wesseling and J. A. Van't Leven. Technical Bulletin 18. 1960.

A Priority Scheme for Dutch Land Consolidation Projects. Publication 6. International Institute for Land Reclamation and Improvement, Postbus 45, Wageningen, Holland.

The following bulletins are available from the Canada Department of Agriculture, Ottawa, Ontario, Canada:

An Electronic Seed Counter, by C. H. Goulden and W. J. Mason. Reprinted from Canadian Journal of Plant Science 38:84-87, January 1958.

A Small Barley De-Awner, by J. G. Kemp, A. E. Hannah, and W. Kalbfleisch. Reprinted from Canadian Journal of Plant Science 39: 241-245, April 1959.

A Photoelectric Device for Measurement of Leaf Areas, by L. S. Donovan, A. I. Magee, and W. Kalbfleisch. Reprinted from Canadian Journal of Plant Science 38:490-494, October 1958.

U. S. Commercial Standard for Douglas Fir Plywood, CS 45-60. Effective date from November 14, 1960. Douglas Fir Plywood Association, 1119 A St., Tacoma 2, Wash.

Irrigation of Snap Beans Grown for Seed in Idaho, by Galen McMaster, Marshall LeBaron, G. L. Corey, Leslie R. Hawthorn, and Vivian K. Toole. Bulletin 336. September 1960. University of Idaho, College of Agriculture, Moscow.

Principles of Tobacco Irrigation, by J. N. Jones, Jr., G. N. Sparrow, and J. D. Miles. Agriculture Information Bulletin No. 228. August 1960. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price, 10 cents.

Russian-English Scientific and Technical Dictionaries: A Survey. 1960. A. F. Hubbell, Professor, Gallatin House, New York University, New York 3, N. Y. Price, 40 cents (U. S. stamps or coin or UNESCO coupons).

Engineering Faculty Recruitment, Development, and Utilization. Report of the Committee on the Development of Engineering Faculties of the American Society for Engineering Education. Reprinted from the Journal of Engineering Education, Vol. 50, No. 9, May 1960. The American Society for Engineering Education, Urbana, Ill. Price, 25 cents.

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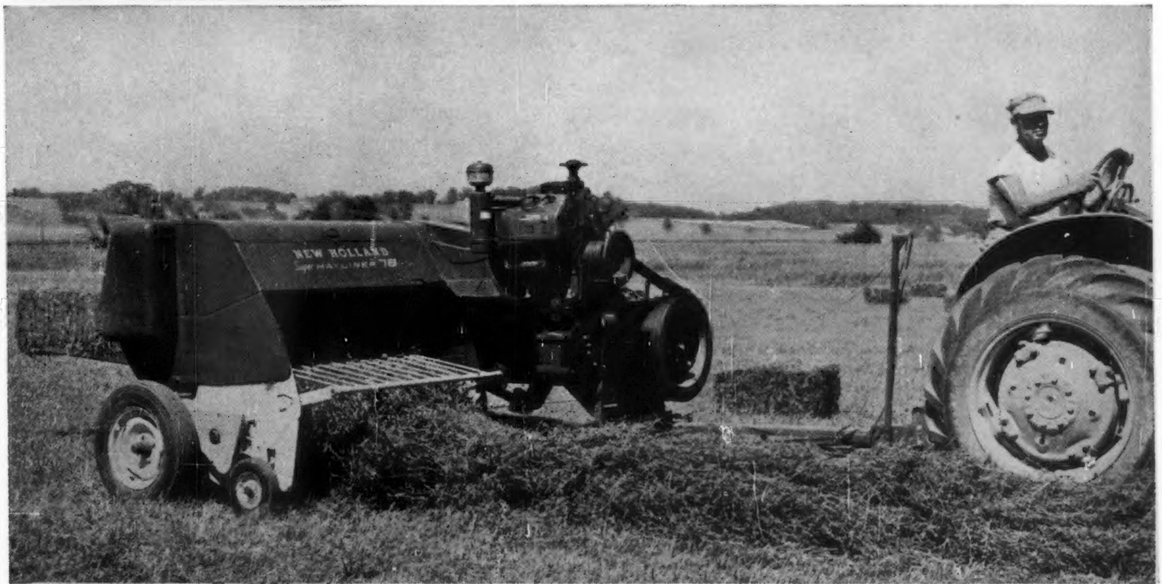

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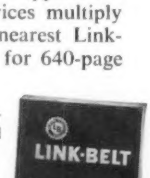

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